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THE UNIVERSITY OF ALBERTA

STUDENT ATTITUDES TOWARDS SCIENCE,
TECHNOLOGY AND CAREERS IN SCIENCE AND TECHNOLOGY

by

Kim Blackwood-Malayko



A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfilment of the requirements for
the degree of Master of Education.

DEPARTMENT OF SECONDARY EDUCATION

EDMONTON, ALBERTA

Fall 1992



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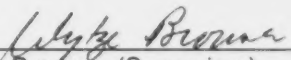
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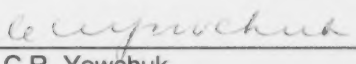
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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled STUDENT ATTITUDES TOWARDS SCIENCE, TECHNOLOGY AND CAREERS IN SCIENCE AND TECHNOLOGY submitted by Kim Blackwood-Malayko in partial fulfilment of the requirements for the degree of Master of Education in the Department of Secondary Education.



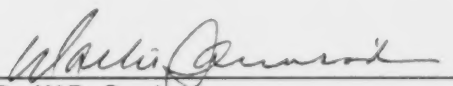
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ABSTRACT

The present investigation was undertaken to determine student attitudes and perceptions of science, science courses, technology, and careers in science and technology. Specifically answers were sought to the following two questions: 1. What attitudes are held by grade three, grade eight, and grade eleven students toward the areas of science and technology? and 2. What attitudes are held by grade three, grade eight, and grade eleven students toward scientific and technological careers?

Thirty-three grade three students, forty-five grade eight students and fifty-eight grade eleven students under the jurisdiction of the Edmonton Public School Board participated in the study.

The instruments used were the Yager and Penick Preferences and Understandings instrument, The Simpson and Troost Attitude Questionnaire, the Views on Science-Technology-Society statements (VOSTS) and a researcher-constructed Student Background Questionnaire. All instruments were administered to the grade eight and grade eleven students. Grade three students completed all but the VOSTS statements as the reading level of VOSTS was too difficult for them. Three students from each grade level, one who liked science, one who did not like science and one who neither liked nor disliked science, participated in Student Interviews conducted by the researcher.

This study found that the most favourable attitudes toward science were expressed by third grade students, next most favourable by eleventh grade students and the least favourable by grade eight students. In general science students found their science classes to be fun and interesting and they felt that their science experiences made them feel curious about their natural world. Science students felt their science teachers encouraged them to present their own ideas. Students identified that they desire relevant curriculum. They want "science", "technology", "practical information that can be useful to everyone" and they want "information that they will need for the future".

On the whole, Edmonton science students appear to hold a reasonably realistic view of science as a career. Students identified that they valued

science and technology and that they had a high opinion of people who were scientists, however, students did not see themselves pursuing a scientific career.

In regard to technology, this research found that as grade level increased students, in turn, provided a more mature understanding of technology. Grade eight and grade eleven students were able to distinguish between science and technology while recognizing their interdependence.

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CHAPTER I

THE PROBLEM AND ITS SETTING

INTRODUCTION

The most beautiful thing we can experience is
the mysterious. It is the source of all true art
and science.

Albert Einstein

As science teachers we provide students with an intelligible continuum of scientific and technological knowledge. We present the history of the various doctrines of science and untangle the secrets of nature's puzzles that have been recorded thus far. We bring understanding to that which at times, appears baffling and elusive. We help young scholars fabricate significance out of their everyday world and aspire to heighten their scientific curiosity along the way - an everyday world that relies heavily on science, technology, and the everchanging spheres of science and technology.

We exist in an era of accelerating scientific, technological and social change. Today change must be viewed as a given and teachers must educate students to comprehend and manage the transforming world and its problems. Educators must help students understand the intricate balances that must endure in order to maintain nature and mankind. We must cultivate an awareness of the relationship that science has with other aspects of the curriculum and an awareness of the interrelationships of the different disciplines of science. We must show our students that science, technology and society are interconnected. We need to teach our pupils how to deal with scientific and technological issues and in doing so recognize that their attitudes toward science and technology play a vital role in how they will respond to scientific and technological information. If students are to make informed, educated and thoughtful decisions in regard to scientific and technological

reports we must ensure that they acquire positive views of science, of scientists, of technology, and of scientific and technological research. In order to develop these positive attitudes we must cognitively and affectively educate and evaluate our pupils. By providing sound scientific and technological information and evaluation we can help these young citizens make wise decisions.

True science education involves both the cognitive and affective profile of the student. Science and technological education can bring into being individuals who are profoundly and genuinely informed, interested and respectful of both regional and global positions relating to science and technology; individuals who can, in turn, make use of scientific and technological information to make informed decisions about social issues that relate to science and technology. Student understanding of science and technology is critical in a society increasingly affected by their impacts.

The importance of student and public understanding of science has been widely recognized as we witness the emergence of an increased number of discussions that relate to scientific literacy. At the community level, people are continually confronted with choices that require some understanding of science and technology: decisions related to whether or not to allow a nuclear plant, or a toxic waste disposal dump, or a landfill to be constructed in your neighbourhood, whether or not to eat high fibre cereals or whether or not to allow a child with AIDS the right to attend regular classes.

As teachers of science we act as facilitators, as guides; we question, we support and ultimately we are responsible for student evaluation. According to objectives proposed specifically for science education, Alberta educators are accountable for assessing a student's cognitive development as well as their affective development. (*Objectives of Secondary School Science for Alberta, Spring - 1970*). On examination of the *Teacher Resource Manual* for the Science 14/24 curriculum (1989 - p. 13) it is evident that former and contemporary learner expectations include the development of a positive student attitude as well as students who possess positive scientific attitudes.

The Edmonton Public School Board has recognized the importance of

educating for the acquisition of positive attitudes toward science and technology as well as appropriate attitudes regarding the responsible application of science and technology. The following list of learner expectations has been taken from their document *Outcomes, Expectations and Indicators for Division IV* (Fall, 1991).

Learning Outcomes Science

1. Students demonstrate the ability to interpret the natural and man-made worlds through processes of independent and cooperative inquiry, problem solving, and decision making.
2. Students demonstrate positive attitudes regarding the pursuit of scientific literacy.
3. Students demonstrate an understanding of the major themes and concepts of science.
4. Students demonstrate appropriate attitudes regarding the responsible application of science and technology.
5. Students demonstrate skill in the use of various forms of communication in the gathering, interpretation, and application of scientific knowledge. (p. SC2)

If science teachers are to teach toward attitude objectives then it should be expected that they will assess the achievement of those objectives. This research looks at the assessment of some of those attitudinal objectives.

This study examines the attitudinal component of science education. It therefore concentrates on the affective profile of the student. In particular it will look at student attitudes toward science and technology and toward scientific and technological careers. This researcher wants to discover whether or not students like or dislike science and whether or not they are interested in pursuing scientific or technological careers.

The focus of this research is to identify student attitudes that exist within schools today. First, this research proposes to examine and identify student attitudes toward science and technology held by grade three, grade eight and grade eleven students. Second, this study will investigate student attitudes toward scientific and technological careers. Specifically, this inquiry hopes to ascertain answers to the following questions:

1. What attitudes are held by grade three, grade eight and grade eleven students toward the areas of science and technology?
2. What attitudes are held by grade three, grade eight and grade eleven students toward scientific and technological careers?

These questions grow out of my experience as a science teacher. As a high school science teacher I work with students who are ultimately planning to attend post-secondary educational institutions. To my amazement many academically talented individuals avoid faculties that are thematically scientific or technological. Students who possess exemplary science ability often do not pursue post-secondary science, engineering or medicine because, as I found from my casual interviews, they believe the time investment is too great and the effort required to be successful is more than they would experience in another faculty. It appears as if they would prefer to take a less difficult, less time-consuming academic program. For this researcher, a number of questions arise:

1. Why don't these students want to "challenge" themselves?
2. How can science educators nurture favourable student attitudes toward science and technology and student interests in science and technology?

3. How can we make students less apprehensive about pursuing professional careers that require lengthy and demanding post-secondary education?

The investigation of the two main research questions will hopefully help to answer these and other questions that will arise along the way. By answering these research questions and their sub-questions I hope to better understand how we, as science educators, can cultivate and nurture positive student attitudes toward science and technology and how we can encourage students with the natural intent and ability not to reject scientific and technological careers without adequate consideration.

This research looks at attitudes as being outcome related. Student attitudes are themselves outcomes reflecting background, environmental and educational influences. It is important to remember that students are not born liking or disliking science as a subject to study. Students learn to like or dislike science based on their experiences.

As educators we want students to acquire positive views of science and

"we should strive to have students express views as follows: science is a positive force in improving the world, scientists may be doing important work, scientific research is worth supporting and a scientific approach is useful in solving problems".

(Raphael and Wahlstrom, 1989, p. 194)

The acquisition of positive attitudes toward science should be a priority for both educators and policy makers for positive attitudes can influence student interest, student learning and student achievement. (Cannon and Simpson, 1985)

The search for effective affective evaluation instruments has proved arduous. Over the course of the last fifteen years paper and pencil attitude evaluation devices have become more plentiful and more legitimate. The function of the affective evaluation instrument is critical. If evaluation of student

attitudes is to be successful it must first be concerned with clearly identifying a set of detailed assessment objectives. The evaluation instruments must attempt to identify behaviours set out in the objectives. The study has selected two Likert-scale instruments that assess student attitudes toward science. These assessment batteries follow the most common approach to attitude measurement which is to obtain a measure of the respondent's agreement or disagreement with a set of opinion statements about the attitude object.

The two major pencil and paper instruments used to survey students for this investigation, the Yager and Penick (1987) *Preferences and Understandings* questionnaire (Appendix A) and the Simpson and Troost (1983) *Attitude Questionnaire* (Appendix B), are designed to assess whether or not students like or dislike science. The Yager and Penick instrument is a Likert-Scale instrument and will be the primary data collection device. The affective battery asks students how they feel about science, science teachers and science courses. The Simpson and Troost questionnaire asks similar questions to those posed by Yager and Penick and has been selected for use because it can, if students respond in the same manner on similar items from the two instruments, provide data consistent with the findings from the Yager and Penick instrument. The Simpson and Troost survey deals with the student's attitude toward science, toward the science teacher and toward the science curriculum. Other subscales such as student perceptions of self, student attitudes about the family and student attitudes toward the classroom and school environment are also included. This study will measure attitude by noting student endorsement or lack of endorsement relative to the attitude object.

Yager and Penick conducted a study in 1984 that surveyed students in regard to their attitudes and perceptions of science, science teachers and science courses. They surveyed nine, thirteen and seventeen year old students and found that the more years students were enrolled in science classes the less they liked it. They also revealed that as students increase in age science is less likely to be seen as being fun and interesting. They found, as well, that students attending science classes see themselves as less successful and

comfortable in science class. Other researchers have published similar findings. Raphael and Wahlstrom (1989) report that "although students at the lower grade levels report great enthusiasm for science and the science taught in school, the enthusiasm wanes at the higher grade levels". (p. 194) Schibeci (1974) reviewed over two hundred studies that had been conducted between 1976 and 1983 and from those studies he found that attitudes to science appear to decline as school students move to higher grades. The Yager and Penick instrument will be used in this study to see if students attending some Edmonton schools reveal similar attitudes. This study will investigate if as student's age increases, student enjoyment and interest in science decreases.

Evaluation appraises a situation. If teachers are to teach toward affective objectives then they must be prepared to appraise whether or not they have achieved those objectives. Affective evaluation, like cognitive evaluation is of value because it may help teachers become more aware of the affective development of their students. Evaluation of student attitudes toward science can provide educators with information that can guide the refinement, improvement or development of teaching methods and materials used within the classroom. Affective evaluation can help teachers refine their professional expertise, so that they may, in turn, untangle the secrets of nature's puzzles for, and awaken scientific curiosity within, their science students.

DELIMITATIONS

The present study examines some but not all of the approaches that may be utilized to evaluate student attitude toward science. The results of this study will not be directly compared to studies other than those of Yager and Penick, and Simpson and Troost. It must be kept in mind, however, that the students and schools in this study were not randomly selected, and that such comparisons can at best be suggestive. This research does not take into account the teaching methods, styles or materials that were used within the classroom. It is understood that these factors do influence student attitude development. This study does not look at which teaching methods and

materials are best to foster the development of a positive attitude toward science and technology. These factors were beyond the scope of the study. It should also be noted that no attempt has been made to obtain specific indications of the socioeconomic status of each student. This investigation does not specifically look at the relationship between student attitudes and student achievement.

LIMITATIONS

The sample size is a limitation of this research. Since the study deals with only two classes of grade three students from an Edmonton Public Elementary School, two classes of grade eight students from an Edmonton Public Junior High School and three classes of grade eleven students all from the same Edmonton Public High School, care should be taken in generalizing any of the results from this research to other grades or jurisdictions.

DEFINITIONS OF TERMINOLOGY

Affective domain: The affective domain is a field of knowledge that pertains to or arises from a person's feeling or emotional reaction.

Attitude: Attitude is a state of mind, behaviour or conduct regarding some matter, as indicating a person's opinion. For the purpose of this study attitude will represent the tendency of a student to show approval or disapproval. (Rokeach, 1968). Attitudes are the emotional reactions of students towards science and they are learned from experiences involving the attitude object or situation.

Attitude Toward Science: Attitude toward science is how a student feels about science. It addresses whether the student adopts a favourable or unfavourable attitude to science, whether or not students like or dislike science, as well as whether or not they are interested in scientific careers.

Positive Attitude: A positive attitude is displayed when an individual expresses affirmation toward the attitude object or situation. For this study it is demonstrated when a pupil adopts a favourable attitude toward science. Statements that express a positive attitude toward science are: I enjoy science courses, I really like science, and I think scientists are neat people.

Negative Attitude: A negative attitude is displayed when an individual expresses negation or opposition toward the attitude object or situation. For this study it is demonstrated when a pupil adopts an unfavourable attitude toward science. Statements that express a negative attitude toward science are: I do not like science. and I feel nervous in science class.

Science: Science is the knowledge of fact, phenomena, and laws gained and verified by exact observation, organized experiment and ordered thinking. Science is people satisfying their curiosity about the world around them (the physical, biological, and technological world) by describing and explaining things and by coming up with ideas that can be experimentally tested by others. In short, scientists seek knowledge for its own sake. Science is done by people - scientists. (Aikenhead, p. 96)

Scientific Attitude: Scientific attitude is exhibited when a person thinks as scientist do, that is to say that a person acts on evidence in a disciplined manner. Scientific attitude includes scientific method and predispositions such as objectivity, suspended judgment, critical evaluation and skepticism. (Gauld, 1982; Munby, 1983a; Blosser, 1984; Haladyna & Shaughnessy, 1982)

Technology: Technology is the application of science and technological advance in industry, manufacturing, commerce and the arts. It is the study or use of the mechanical arts and the applied sciences. Technology responds to human needs by discovering, designing, and producing things or ideas for society. Technology applies its own knowledge (things or ideas) to solve practical problems. Technology is done by people - technologists. (Aikenhead - p. 97)

Technological: Technological pertains to the practical application or use of technology.

The most common approach to attitude measurement is to measure the student's agreement or disagreement with a set of opinion statements about the attitude object. In this study students had the opportunity to complete two such instruments. First, students from grade three, grade eight and grade eleven completed the Yager and Penick (1987) *Preferences and Understandings* instrument. Second, they completed the Simpson and Troost (1983) *Attitude Questionnaire*. These two assessment devices contain similar items as well as different items. The Yager and Penick instrument was the primary data collection source, whereas the Simpson and Troost battery was administered to see if there is response consistency for the items that are similar. At the same sitting students were asked to complete a researcher-constructed Student Background Questionnaire. This questionnaire allowed students to respond

in a written format. Students were asked to define terminology such as science and technology, to state why they like science or why they do not like science and to comment on what they think should be taught in science classes. The nineteen-item questionnaire can be found in Appendix D and was administered to gain the reasons that lie behind some of the Likert-scale responses. It is hoped that the questionnaire will offer support and enhancement to findings secured from the other assessment devices.

Grade eight and grade eleven students responded to a condensed version of the *Views on Science-Technology-Society* statements otherwise known as the VOSTS statements. (1988) Grade three students were not asked to complete this document as the reading level was too difficult for them.

Three students from each grade level were interviewed to find out more about why students have responded as they have on the paper and pencil instruments. Aikenhead (1988) tells us that interviews provide a wealth of information. This researcher agrees with Aikenhead and as attitudes are unverifiable except by report of the individual it was decided that a small number of interviews would be conducted in order to add to the information pool. As interviews are time consuming, only three were conducted at each grade level. An attempt was made to interview one student who liked science, one who did not like science and one who appeared to neither like nor dislike science at each grade level. The interview group was not identified until all students had completed the paper and pencil instruments. A more detailed account of the instruments and procedures used will be provided in the chapters that follow.

Chapter Two will provide a glimpse of the history of attitude research and a review of the literature encountered during the course of this investigation. Chapter Three will specifically identify the research sample that participated in this study. It will also provide a more detailed description of the instruments used. The actual instruments can all be found in the Appendices. As well, Chapter Three will describe the procedure followed. Chapter Four will discuss the findings from the Yager and Penick *Preferences and Understandings* instrument and from the Simpson and Troost *Attitude Questionnaire*. Chapter

Five will address the findings from the *VOSTS* statements, the Researcher constructed *Student Background Questionnaire* and the student Interviews. The final chapter, Chapter Six, will summarize the study, review the findings, and provide suggestions for further research that have surfaced.

CHAPTER II

A REVIEW OF THE LITERATURE

INTRODUCTION

Journal articles criticize attitude research in several respects. One of the major criticisms has been the fact that there have been many definitions of attitude presented in the literature. With the variety of definitions that exist it becomes clear that there has not been one definition of attitude to which all researchers agree upon. As a result, attitude research becomes difficult to compare when the constructs are not consistent. A second criticism is that there has been difficulty in finding effective affective evaluation instruments. Chapter two will look at attitude research in an historical sense and discuss why affective evaluation has proved to be more awkward to conduct than cognitive evaluation. It will also reveal the various definitions of attitude that have been presented as well as, some of the student toward science research findings.

**WHY IT HAS BEEN DIFFICULT TO FIND EFFECTIVE
AFFECTIVE ASSESSMENT DEVICES**

When reading documents that outline educational aims one generally discovers that a substantial percentage of these objectives relates to the development of the students' cognitive abilities. One will find that there are abundant resources available to support cognitive development and to certify student achievement or cognitive behaviour. These resources are undoubtedly necessary and valuable for they aid students in their acquisition of major educational themes and concepts. On the other hand, a lesser percentage relates to enhancing the affective profile of the student. Affective development support materials and evaluation instruments are not plentiful and they have proved difficult to find. "Cognitive outcomes are recognized by

most members of our society as being paramount educational goals. The way individuals feel toward school, learning and science after finishing their formal education would appear equally important". (Cannon & Simpson, 1985, p.135)

Historically the search for accurate affective development instruments has been a formidable task. Krathwohl, Bloom and Masia (1956) found that affective domain evaluation done prior to 1956 was marginal. The authors found that affective evaluation had been done either when someone was completing educational research or when someone was responsible for addressing a pressing question that had been raised by members of their faculty. This is because affective attributes have proved more awkward to measure than that of cognitive attributes, awkward because the construct of attitude has been described as being vague, inconsistent, ambiguous and weak theoretically (Germann, 1988) and also because attitude research has often been conducted without taking into account the relationships that attitude maintains with other variables. When one considers that attitudes are learned from experiences involving the attitude object and when one thinks of attitudes as being learned behaviours and not inherited behaviours it becomes important to take into consideration the various, intricate relationships that each of us sustains on a daily basis.

Bloom (1956) describes the affective domain as involving the development of interests, attitudes, values, and appreciations, and adjustments. (p. 7) Sterling McMurren (taken from Wareing, 1990, p.373) upon examining the affective human function as it relates to instruction, tells us that affect

"pertains to the practical life --to the emotions, the passions, the dispositions, the motives, the moral and aesthetic sensibilities, the capacity for feeling, concern, attachment or detachment, sympathy, empathy, and appreciation".

Differences exist between the cognitive and the affective domains. If

we look specifically at each domain we find that evaluation techniques used to measure cognitive development will not adequately measure affective development. Krathwohl, Bloom and Masia in their handbook **Taxonomy of Educational Objectives The Classification of Educational Goals. Handbook II: Affective Domain** (1964) suggest that the four following factors have been influential in making affective characteristics, such as attitude, more difficult to measure or assess.

First, as a society we tend to regard beliefs, attitudes, values and personality characteristics as being predominantly "private matters". Our culture rewards those who keep their "feelings to themselves" or their "feelings in check". This makes observations of emotional responses more difficult especially with the older, "experienced" students in our schools.

Second, some examiners find it inappropriate to assess students in respect to their attitudes or interests. Krathwohl, Bloom and Masia (1964) believe it has been because appraisal techniques have been inadequate. The authors also found that students may exploit their ability to be able to detect responses that they feels they will be rewarded for.

Third, it is evident that affective behaviours undergo far more sudden transformations than do cognitive behaviours. Some affective behaviours develop more slowly and as a result require appraisal techniques that can be implemented over long periods of time.

Fourth, from a researcher's perspective it is difficult to evaluate affective objects with validity, objectivity and reliability. It is difficult to apply specific standards when assessing the affective domain of an individual because of the various factors, themselves poorly understood, that shape the attitudes, beliefs, and interests of the student. Examples of factors that shape attitude formation would be that the affective domain is influenced by the numerous "learning experiences" individuals face each day, by the "in school" or "out of school" environments or by their home environments.

DEFINING ATTITUDE

Historically attitude has been used to describe a variety of situations. Early in the Eighteenth Century attitude was used to characterize the physical posture of immobile figures and later it became the way to depict the posture or movement among actors and dancers. (Fleming, 1967) According to Fleming, Darwin moved attitude from theatrics to real life during the mid-1800's. Darwin used attitude to describe the emotional readiness of animals in a state of crisis. He used attitude as an evaluative quality. (Shrigley, Koballa, & Simpson, 1988). In the early years of the twentieth century Thomas and Znaniecki (1918) in their work *The Polish Peasant in Europe and America* used attitude to describe the acculturation of Polish peasants in Urban America, thus moving the description of attitude from a physiological to a psychological arena.

Today the physical description of attitude still exists. Looking at Funk and Wagnalls' Standard College Dictionary (p. 94) attitude is defined as "position of the body, as suggesting some thought, feeling or action" or "the position of a vehicle with reference to some plane, as the earth or the horizon". Attitude is also defined as Fishbein and Ajzen (1975) contend as "a learned predisposition to respond in a consistently favourable or unfavourable manner toward an attitude object". (p. 6) An example of an attitude as a learned behaviour would be how people feel about snakes. We are not born with attitudes toward snakes. We learn our attitudes toward snakes from experience either actively or vicariously. Students are not born liking or disliking a particular subject. Students learn to like or dislike. Attitudes, being learned, are susceptible to change, "but they are not momentarily transient". (p. 116) Attitudes are learned behaviours that can be changed from negative to positive by activities and experiences that are meaningful for the student.

The following definitions of attitude appear in the literature. Germann (1988) uses descriptions provided by Gauld (1982), Munby (1983a), Blosser (1984), and Haladyna and Shaughnessy (1982). They depict that attitude as it relates to science should be divided into two areas. Area One is that of

scientific attitude. Scientific attitude is when a person thinks as scientists do, that is to say that a person acts on evidence in a disciplined manner. Scientific attitude includes scientific methods and predispositions such as objectivity, suspended judgment, critical evaluation and skepticism. Area Two is a different construct entitled attitude toward science. This construct may address scientists, scientific careers, methods of teaching science, scientific attitudes or the relationship between science and technology. Bogardus (1960) likens attitude to being a trap waiting to be sprung by the right stimulus. Allport (1968) characterizes an attitude as being "a state of readiness for mental and physical activity" (p. 60). Bem (1970) writes that our "attitudes are our likes or dislikes". Rokeach (1968) defines attitude as being a "relatively enduring organization of beliefs around an object or situation predisposing one to respond in some preferential manner", or as a tendency to take a positive or negative position toward the attitude object. This research defines attitude toward science in the same manner as Bem (1970), Fishbein and Ajzen (1975) and Rokeach (1968); that definition being the emotional reactions of students toward science. Specifically it investigates whether students like science, whether they find their science classes to be interesting, whether they think scientists are "neat" people and whether they think being a scientist would be fun.

Shrigley, Koballa, and Simpson (1988) state that "without a clear definition, attitude research and even dialogue among science educators are hampered" (p. 660) in discussions because as a society we are prone to use attitude interchangeably with belief, opinion and value.

Krynowsky (1988) identifies some of the problems that ultimately arise when one attempts to assess student attitudes as they relate to science education. Krynowsky states that one of the major problems that has existed has been that of the lack of conceptual clarity. Terminology such as attitude and science conjure up different definitions for different individuals, thus attitude research "language" has provided confusion for those involved in attitude assessment. Confusion has also existed in regard to the difference between the descriptors "scientific attitudes" and "attitudes toward science".

The mixing of different constructs results in the lack of clarity as well as the lack of the ability of researchers to be able to compare research findings.

Looking at the research it is evident that attitude has been defined in a variety of ways. Therefore, readers must be careful when comparing research for the word "attitude" conjures up different meanings for different people. Blosser (1984) tells us that there has tended to be no consistency with respect to the construct of attitude instruments. Science educators and researchers must define the term carefully for themselves.

The term "science" has also provided some confusion in regard to definition. Klopfer (1976), Munby (1983) and Fraser (1977) found the following meanings to be most common: science instruction, science careers, science itself, the work of a scientist, specific science issues, science as a school subject and scientific attitudes. This lack of a clear cut definition of science combined with the criticism that these characteristics may or may not be components of student attitudes can add to the lack of clarity that at times exists in science attitude assessment methodology.

There have been semantic problems with the multiple meaning attached to the term "attitude toward science" in the educational literature. As one examines attitude research it becomes clear that science educators and researchers must clearly and carefully define the terminology used.

Gauld (1982), Munby (1983a), Blosser (1984), and Haladyna and Shaugnessy (1982) suggest that research into attitudes must clearly identify which aspect of attitude is being addressed. This can undoubtedly help to eliminate or decrease the ambiguity.

Wareing (1990) believes that affective education should focus on student "attitudes toward science" rather than concentrating on the cognitive nature of attitude referred to as "scientific attitudes".

She quotes Rubin (1973):

there is no reason why the cognitive lessons we wish children to learn cannot be brought to bear upon their affective concerns, or the reverse. All of which is to say that feelings and facts can be joined together in a mutual alliance ... in a healthy curriculum, there is a simultaneous interplay between cognition and affect.

Wareing suggests that if researchers want to better understand students' attitudes toward science they should consider exploring:

1. clear and mutually acceptable definitions;
2. theories and models of attitude development;
3. variables which contribute to or detract from attitude development;
4. the extent to which students are able to identify, through hindsight, contributory variables and antecedents of attitudes;
5. the differences between students with favourable versus unfavourable dispositions toward science and their self-reported perceptions of attitude antecedents;
6. whether instruction can be tailored or modified to mitigate differences. (Wareing, 1990, p. 373)

ATTITUDE ASSESSMENT DEVICES

A second problem has been associated with the instruments used to collect data. Krynowsky (1988) points out that Munby (1980) found, upon the analysis of 50 attitude to science instruments, that "there are grounds for viewing the affective outcomes of science education with misgivings simply because there seems little to be said of the instruments to enlist our confidence in their use" (p. 273).

Krynowsky concludes by stating that he hopes that future science education researchers will work to improve the quality of attitude research instruments and ultimately the subsequent research results.

Kozlow and Nay (1976) discuss possible reasons that teachers may neglect attitude development activities when they plan their classroom activities. Inadequate teaching methods and materials that would be suitable for the development of interests, attitudes and values are cited as being important factors (p. 147). Another contributing factor is the dearth of evaluation instruments and techniques (p. 147). Many of the available instruments provide definitions of attitude that are very general. The instruments do not discriminate between affective and cognitive components present in attitude measurement and in many cases there has been a tendency to put together several dimensions of science under the umbrella definition of science.

Attitudes, values, interest, emotional sets or biases have proved more difficult to measure or assess. They do, however, exist and do warrant being taken into account. Krathwohl, Bloom and Masia (1964) recognize the importance of dealing with the affective domain. They pose the question "does a human being ever think without feeling or act without thinking?" Both cognitive and affective behaviours of students must be understood so that educators may be able to teach the "whole student".

ATTITUDE RESEARCH FINDINGS

Schibeci's review (1982) of over 200 studies conducted between the years 1976 and 1982 arrived at five provisional conclusions that could be derived from attitude research findings.

1. Gender appears to be an important variable, both alone and and in interaction with other variables.

2. The effect of particular science programmes on attitudes varies considerably. There is not consistent set of results for this variable.
3. Home background and peer group variables are probably important, but the influences are not direct.
4. "Science" must be divided into physical and biological science. Students' attitudes to biological science appear generally to be more favourable than to physical science.
5. Attitudes to science appear to decline as students move to higher grades. (p. 46)

Long term attitudinal studies have not been the norm, thus very little is known about how attitudes develop and change over time; over the course of a students' schooling. Oliver and Simpson (1988) conducted one such study and they found that affective behaviours in science are 'strongly' related to achievement.

Oliver and Simpson (1988) completed a longitudinal study that tracked achievement of high school students in science while observing if self-reports of affective constructs could be successfully used to predict their achievement. Their goal was to investigate commitment to science and achievement in science in respect to outside influences of home and school. Data was collected over the 1980-1981 school year from five thousand students in grades six to ten. Affective and achievement variables were measured at the beginning, the middle and the end of the school year. The research was completed in North Carolina in a large and socially diverse school setting. Achievement data was collected from a search of school records. Data regarding student interest in reading science was collected using a Likert-scale. Attitudes were assessed using a fifty three item instrument. Follow up data was collected during the 1985 - 1986 school year.

Billeh and Zakhariades (1975) address the fact that emphasis has been given to the development of scientific attitudes through formal classroom education. Heiss (1958) stated that the lack of an appropriate instrument for

measuring these attitudes handicapped researchers. This realization led to the primary purpose of this investigation, which was to develop a Thurstone-Clave scale to measure scientific attitudes. Billeh and Zakhariades (1975) found that all groups studied, those being secondary school students, university students and science teachers, demonstrated positive scientific attitudes. As well, they found that the amount of science knowledge and/or general exposure to science courses positively affects science attitudes. Science courses at the University appeared to be effective in developing positive changes in scientific attitudes of students, whereas twelfth grade to sophomore courses did not. They also found that experience in teaching secondary school science was not a factor in further developing scientific attitudes.

Cannon and Simpson (1985) found that science attitude was more positive at the beginning of the year than at the end. The advanced ability group students demonstrated a more positive attitude than the basic ability group. These patterns were observed for both male and female students. The study found that students with a positive attitude develop a deeper appreciation and understanding of science and as a result they achieve more. Factors that are associated with a decline in attitude were found to be irrelevant curricula, ineffective teaching methods and strategies, and inhibiting classroom environment. They also found that males have more positive attitudes than do females, but females were more motivated than males to achieve in science. Their research sample consisted of a large socially diverse school system in central North Carolina. During the 1980-1981 school year students were selected from seventh-grade life science classes. Final sample size was 821. The research design used was a modified time-series repeated measures from Campbell and Stanley (1963). They measured attitude toward science using the Simpson and Troost *Attitude Questionnaire*, achievement, motivation and achievement in life science at the beginning, the middle and the end of the school year. Achievement scores for these students were also provided by the *California Achievement Test* they had completed in the sixth grade.

Barrington and Hendricks (1988) conducted a study with 143 intellectually gifted and intellectually average third, seventh and eleventh grade Wisconsin students in which students completed the Yager and Yager (1985b) questionnaire based on NAEP affective items. This instrument measures both attitudes toward science and scientific knowledge. They found that the most favourable attitudes were expressed by third graders, next most favourable by eleventh graders and clearly the more negative attitudes were expressed by students in the seventh grade. "In many respects the students have better perceptions concerning science, science classes, science teachers, the value of science, and what it is like to be a scientist in grade three than when they are in grade eleven" (Barrington & Hendricks, 1988, p. 679). They also found that there were no significant gender effects for any attitudinal scale. These findings are of interest when one considers that the generally accepted belief is that males have more positive attitudes toward science than do females. This study indicates that sex-role expectations are not discouraging females from having an interest in science.

Joseph Menis (1989) reports that grade twelve students have a more positive attitude towards school, chemistry and science than do grade eleven students, that 9.4% of the grade twelve population would choose science as a career and that students, in general, report that they believe that science is an important component of twentieth century life. Menis also found that 44% of grade elevens and 71% of grade twelves thought science was an enjoyable school subject and that 49% of grade elevens and 69% of grade twelves thought that the science taught in schools is interesting. When looking at pursuing a science related career 39% of grade elevens and 55% of grade twelves thought working in a science laboratory would be an interesting way to earn a living.

His paper is based on the results of the second IEA study (SISS). The results come from a two phase study that was conducted in the United States. Phase one analysed science curricula in the United States and phase two looked at opportunity to learn science, students' achievement and attitudes.

The study used an attitude questionnaire based upon a three-level-scale of agreement, that scale being agree, disagree and uncertain. The attitude questionnaire was completed by upper elementary (grade five), lower secondary (grade 9) and upper-secondary (grades eleven and twelve) students. For this investigation attitude was defined as being an affective reaction to stimuli, for example like/dislike or enjoy/not enjoy.

Bohardt (1975) examined changes in attitudes of children in grades four through eight toward process-based instructional science programs. He found that fourth and fifth graders possessed positive attitudes but, as grade level increased, attitude decreased.

Talton and Simpson (1985) found, using the Simpson and Troost *Attitude Questionnaire* (1982) that the physical environment and school were not significant predictors of attitude toward science. In their population the classroom maintained the strongest relationship with attitude toward science. They suggest that by increasing teacher awareness about the significant role that the classroom environment may play in the development of student attitudes toward science it could be possible to increase student interest and student success in science. In order to accomplish the aforementioned the classroom would have to be "fashioned into a stimulating, supportive environment in which students may question and develop their interest in science." (Talton and Simpson, 1985, p. 373)

School environment was not the only significant variable. Self-concept and home environment or family also played significant roles in forming student attitudes toward science.

They suggest that "by increasing positive feelings toward a specific discipline the discipline related self-concept will improve." (Talton and Simpson, 1985, p. 367) and "by improving and strengthening commitment to science in the areas of home and classroom, student self-commitment and enjoyment of science should increase" (Talton and Simpson, 1985, p. 373).

The Talton and Simpson (1985) research examined the relationship between the independent variables of self, family and classroom environment and the dependent variable of student attitude toward science. Their study

involved a stratified random sample of science students from grades six to ten and was conducted in a large and socially diverse system from North Carolina.

The Yager and Penick (1986) study asked grade threes, grade eights, grade elevens and young adults to respond to questions about science classes, science teachers and the value of science study. They found that science classes were perceived as being most fun, most interesting, and most exciting by nine-year-old students. Responses from thirteen-year-old students, seventeen-year-old students and young adults showed that as age increases, interest and enjoyment of science decreases. They concluded that the more years students enrol in science classes, the less they like it. They suggested that science teachers must begin teaching real-world science dynamically in order to change their perception of science and meet their educational needs. A more detailed report of their work will be included in Chapters three and four, as this study uses their data collection instrument.

CANADIAN ATTITUDE RESEARCH FINDINGS

Some Canadian research has been conducted in this area. In May of 1984 twenty-thousand Canadian students participated in a survey that was part of Canada's involvement in the Second International Science Study. One of the objectives of the study was the testing and revision of a student and teacher attitude questionnaire. Data from the survey was presented provincially and nationally. A brief summary of the findings follows.

A science assessment conducted in British Columbia reported the following findings. At the grade four level 80% of students thought of science as an important school subject. 67% of grade eight males and 59% of grade eight females responded that they liked to study science. 19% of grade eight students professed an interest in pursuing a scientific career. 18% of grade tens and 21% of grade elevens professed that they would like to become scientists.

The Alberta Achievement Testing Program reported that 55% of grade

three students liked learning science. 60% of grade six students expressed an interest in science. The general finding of the program was that students show positive attitudes toward science.

Grade five students from Manitoba had a strong interest in and a positive attitude toward science. 70% of students professed an interest in acquiring a science related career. More males than females indicated the aforementioned. The grade eight population reported an interest in science and science related activities. More males than females believed a career in a scientific field would be of interest and more females reported positive attitudes toward science than did males. Mixed reports arose from grade eleven students in regard to interest in science. Male students were more interested in science than females. Females were more positive about scientists and 50% of females think that a career in science would be appealing.

Ontario students tended to hold positive attitudes in regard to experiments and they approved of science as an area of human activity. Students agreed that science is important to both the individual and to society.

In general the Canadian study came to the following conclusions:

"A remarkable consistent picture has begun to emerge; students especially younger ones, indicate generally positive attitudes towards science, boys have more favourable attitudes towards science than do girls, and most students do not want careers in science."

(Raphael and Wahlstrom, 1989, p.196)

Canadian students were generally positive about possible careers in science, the exception being that they definitely do not want to become science teachers. Students' plans for pursuing post secondary education and careers showed traditional gender differences. Female students were more attracted to careers in health science, whereas males were more interested in the engineering and technology sector.

IN CONCLUSION

More than one study found that as grade level increases student attitude toward science deteriorates. (Bohardt, 1975, Schibeci, 1982, Yager & Penick, 1986.) Other studies found, as did this study, that student attitude toward science wanes for Junior High students but remains very positive for Elementary and High School students. Raphael and Wahlstrom describe the aforementioned in the following manner.

"The general enthusiasm for schooling seen among grade five students has probably worn away by grade 9, and has not been replaced by genuine interest in science studies, as is the case among grade 12/13 students".

(Raphael and Wahlstrom, 1985, pg. 215)

It might be that Junior High students are struggling with and using their energy to finding out who they are, whereas Elementary and High School students are not so immersed in the quest for self identity. High School students have more than likely become more focused and career directed than their junior counterparts.

Chapter three will discuss in detail the research sample, what instruments were used, what procedures were followed and what kinds of data were collected.

CHAPTER III

THE SAMPLE, THE INSTRUMENTS AND THE PROCEDURE

INTRODUCTION

One hundred and thirty six students enrolled in schools under the jurisdiction of the Edmonton Public Schools participated in the study. Thirty three students were from grade three, forty-five were from grade eight and fifty eight were from grade eleven. All students involved in the study completed a modified version of the Yager and Penick *Preferences and Understandings Instrument*. (Appendix A)

A second instrument, the Simpson and Troost *Attitude Questionnaire* (Appendix B), that contained similar items to those presented in the Yager and Penick instrument was utilized as well. It was decided that a modified version of this instrument would be completed by students in hopes that it would provide conclusions that could support those found by the Yager and Penick survey.

A third instrument known as the *Views on Science-Technology-Society* statements (VOSTS) (Appendix C) was completed by the Junior High and High School students. The reading level of this document was too difficult for grade three students, thus they were not asked to complete it. It was thought that the format of the VOSTS statements would provide students with a rating system that did not follow a Likert-scale format. The VOSTS statements were also used to provide more detailed information in regard to student attitudes toward technology and toward technological careers.

A fourth researcher-constructed Student Background Questionnaire was also completed by all students. (Appendix D) This instruments allowed students to provide written responses as to why they liked science, why they did not like science, what they thought should be taught in science classes, how science teachers could make the science classroom a more interesting place for students, and what kinds of careers they were interested in pursuing.

This questionnaire was administered to gather information that would provide explanations as to why students liked or did not like science, and to shed some light in regard to the careers our students are interested in pursuing.

The final information gathering strategy was that of the student interview. Only three students at each grade level were interviewed due to time constraints. The interviews were conducted in an attempt to acquire reasons for student responses found on the aforementioned questionnaires.

The instruments, identified above, were administered to collect information on student attitudes toward science and technology and student attitudes toward scientific and technological careers. A more detailed description of the research sample, the instruments utilized and the procedure used follows.

DATA COLLECTION

Data was collected from grade three, grade eight and grade eleven students attending schools located within the Edmonton Public School District. Instruments used were the Yager and Penick *Preferences and Understandings* Instrument (Appendix A), The Simpson and Troost *Attitude Questionnaire* (Appendix B), and the *Views on Science - Technology - Society statements* (Appendix C), otherwise known as VOSTS. Students also completed a researcher-constructed Student Background Questionnaire (Appendix E).

THE SAMPLE

The research sample consisted of two grade three classes from an Edmonton Elementary school, two grade eight science classes from an Edmonton Junior High School, and a Science 24 class, a Biology 20 class and a Physics 20 class from an Edmonton High School. The rationale for selecting three different science subject areas at the grade eleven level was to allow the researcher access to an appropriate and varied cross-section of

high school students. All students involved in the study were from schools under the jurisdiction of the Edmonton Public School Board.

THE RESEARCH SAMPLE

a) Elementary Students	N = 33	23 males - 10 females
b) Junior High Students	N = 45	23 males - 22 females
c) High School Students	N = 58	31 males - 27 females
Science 24	N = 15	
Biology 20	N = 15	
Physics 20	N = 28	

INSTRUMENTS

Paper and pencil questionnaires and Likert-Scale instruments were used to gather data. A researcher-constructed Background Questionnaire (Appendix E) was administered to all three grade levels. It was only partially completed by the grade three students due to their inability to comprehend some of the terminology that was included within the document. I did not expect the grade three students to be able to fully complete this document, as some of the questionnaire was above their reading comprehension level, but asked the teachers involved in the study if they would have their students attempt completing it to see what information they might provide. It was fully completed by the grade eight and eleven students. All students completed the Yager and Penick *Preferences and Understandings* Instrument (1987, Appendix A), the Simpson and Troost *Attitude Questionnaire* (1983, Appendix B). The grade eight and the grade eleven students responded to twenty six out of one hundred and fourteen of the *Views on Science-Technology-Society statements (VOSTS)* (1988). The reading comprehension level of this document was too difficult for the grade three students and thus they were not asked to complete the VOSTS statements.

THE YAGER AND PENICK PREFERENCES AND UNDERSTANDINGS INSTRUMENT

A survey conducted in 1984 by Yager and Penick assessed, as their research title implies, the *Perceptions of Four Age Groups Toward Science Classes, Teachers and the Value of Science*. Yager and Penick accessed information using their *Preferences and Understandings* instrument which contains forty eight items. This affective battery was designed to ascertain "student attitudes and perceptions of science, science teachers, and science courses". (Yager and Penick, p. 355) This review was a follow up study that had as its objective further data collection with respect to affective items for the on going National Assessment of Educational Progress (NAEP) study. Yager and Penick gathered their data from a stratified random sample of seven hundred and fifty 9, 13, and 17 year old students and three hundred and ten young adults, ages twenty five to thirty five, from twenty nine Iowa school districts. All teachers involved in the study were members of the National Science Teachers Association (NSTA). The nine, thirteen and seventeen year old students completed the same instrument. The young adults completed an instrument that used the same items asked in the past tense. The Yager and Penick instrument required approximately fifteen minutes to administer. This study parallels the aforementioned study as it surveys students from three different grade levels about their attitude toward science using a modified version of the attitude assessment instrument designed by Yager and Penick. Yager and Penick questioned grade three students, grade seven students, grade eleven students, and young adults to assess their perceptions toward their science classes, teachers and the value of science. This research asks the same research questions of grade three, grade eight and grade eleven students. A modified version of the *Preferences and Understandings* instrument was completed by all students who participated in the Edmonton study.

The Yager and Penick *Preferences and Understandings* Instrument (1984, Appendix A) is used to assess student attitudes and perceptions of

science, science teachers and science courses. The actual instrument consists of forty eight statements. This study uses forty of the original forty-eight items as eight of the original statements do not apply to this particular study. The eight that were eliminated had students select definitions for science terminology such as volume, organism, motion, enzyme, molecule and cell. These statements represent three subscales: Science Classes, Science Teachers and Value of Science Study. Specific questions in each category subscale included:

Yager and Penick Preferences and Understandings
Subscales

Science Classes:

1. Is your science class fun?
2. Is your science class interesting?
3. Is your science class exciting?
4. Does your science class make you feel uncomfortable?
5. Does your science class make you feel comfortable?
6. Does your science class make you feel curious?

Science Teachers:

1. Does your science teacher ask you questions often?
2. Does your science teacher like for you to ask questions?
3. Does your science teacher ever let you give your own ideas?
4. Does your teacher really like science?
5. Does your teacher make studying science exciting?
6. Does your teacher know a lot about science?
7. Does your teacher admit to not knowing answers to your questions?

Value of Science Study:

1. Are the things you learn in science useful to you when you are not in school?
2. Do you feel that your study of science will be useful if you study more science?
3. Do you think that knowing a lot about science will help you in the future?

For the purpose of this research the subscales were modified slightly to include a category that would provide information about student attitudes towards careers in science. One of the two original research questions asked "what attitudes are held by grade three, grade eight and grade eleven students toward scientific and technological careers. A career subscales was added to answer this question. The revised subscales follow.

The Revised Yager and Penick
Preferences and Understandings Subscales

Science Classes:

1. Is your science class fun?
2. Is your science class interesting?
3. Is your science class exciting?
4. Does your science class make you feel successful?
5. Does your science class make you feel curious?

Science Teachers:

1. Does your science teacher ask you many questions about science?
2. Does your science teacher like for you to ask questions about science?
3. Does your science teacher encourage you to give your own answers?
4. Does your science teacher really like science him/herself?
5. Does your teacher make studying science exciting?
6. Does your teacher know much science?
7. Does your science teacher admit to not knowing answers to your questions?

Science Career:

1. Do you think that being a scientist would be fun?
2. Do you think that being a scientist would make you rich?
3. Do you think that being a scientist would be a lot of work?
4. Do you think that being a scientist would be boring for you?
5. Do you think that being a scientist would make you feel important?
6. Do you think that being a scientist would make you lonely?
7. Do you talk about science careers in science class?

Value of Science:

1. Are the things you learn in science useful to you when you are not in school?
2. Do you think that knowing science will help you in the future?
3. Do you feel that the science you study is generally useful to you?
4. Do you feel that your study of science is useful in helping you to make choices?

THE SIMPSON AND TROOST ATTITUDE QUESTIONNAIRE

The Simpson and Troost *Attitude Questionnaire* (Appendix B) was developed specifically for use in a research project carried out by Kalup Cannon, and Simpson (1985). The project was supported by the National Science Foundation. Their study examined the relationships among attitude, motivation, and achievement of ability grouped, seventh-grade, life science students. The instrument was reviewed item by item by a five member expert panel of sociologists and science educators for content validity. During the project's first year, reliability measures using the Kuder-Richardson 20 were determined on more than one version of the instrument. The final questionnaire was found to have a reliability estimate of 0.95 (KR 20) for the seventh-grade students involved in the aforementioned study.

The Simpson and Troost Attitude Instrument (Revised 1/83) consists of sixty statements that have been designed to sample student opinions about science. This study used forty five items. Those not used were deleted because they were not related to this particular study. The deleted items asked questions that related specifically to the performance of the teacher or the school principal. The Simpson and Troost instrument incorporates fourteen subscales. These fourteen subscales assess student attitude toward self, family, classroom environment, and science.

LIKERT-SCALES: The attitude-measurement technique developed by Likert (1932) has been widely used and a large portion of the attitude scales which have been constructed are of this type. Likert-scales use of a list opinion statements regarding the attitude object. Respondents are asked to

circle one of the following responses for each statement: Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree. The Simpson and Troost *Attitude Questionnaire* follows this Likert-scale format.

A number of weaknesses have been identified with attitude instruments that follow the Likert-Scale format. An example of this might be that the variation in attitude between Strongly Disagree and Disagree might not be the same as the distance between Disagree and Undecided. These variations may also vary between respondents. Also, it's not always sure that students indicate the same Likert-scale responses for the same items.

The Simpson and Troost *Attitude Questionnaire* used the following four subscales were used to measure student perceptions of self.

Self-Achievement Motivation:

1. I always try hard, no matter how difficult the work.
2. When I fail that makes me try much harder.
3. I always try to do my best in school.
4. I try hard to do well in science.

Science Anxiety:

1. Science makes me feel as though I'm lost in a jungle of numbers and words.
2. My mind goes blank when I am doing science.
3. Science tests make me nervous.
4. I would probably not do well in science if I took it in college.

Science Self-Concept:

1. I consider myself a good science student.
2. I think I am capable of becoming an engineer, scientist or doctor.

General Self-Concept:

1. I like myself.
2. I feel I have a number of good qualities.

The following two subscales measured student attitudes about the family.

Family - - General:

1. I argue a lot with my family.
2. I am a member of a happy family.
3. My parents expect me to do well in school.

Family - - Science:

1. My family watches science programs on TV.
2. My parents help me with my science homework.
3. My brothers and sisters like science.
4. My father likes science.
5. My mother likes science.

Student attitudes toward classroom and school environment were measured using the following seven subscales.

Science Class - - Climate:

1. I feel nervous in science class.
2. I usually look forward to my science class.
3. This class is a good place.

Science Curriculum:

1. We do a lot of fun activities in science class.
2. We learn about important things in science class.
3. We cover interesting topics in science class.
4. I like our science textbook.

Science Class - - Physical Environment:

1. I consider our science classroom attractive and comfortable.
2. Our science classroom contains a lot of interesting equipment.

Science Teacher:

1. My science teacher encourages me to learn more science.
2. I enjoy talking to my science teacher after class.
3. My science teacher makes good plans for us.
4. Sometimes my science teacher makes me feel dumb.
5. My science teacher expects me to get good grades.

Other Students:

1. I don't have many friends at this school.
2. I don't have many friends in this class.
3. The students work together well in this class.
4. The students in this class aren't much fun.

Friends:

1. My best friend likes science
2. My best friend in class likes science.
3. My friends like science.
4. Most of my friends do well in science.

School:

1. Most teachers at this school are fair with students.
2. I feel like I'm in prison when I'm at school.
3. I am under great pressure at school.
4. The principal of this school is nice.
5. I feel like I have little control over what happens to me at school.
6. The harder I try, the better I do in school.

Student attitudes toward science were obtained using the following and final seven item subscale.

Attitude Toward Science:

1. Science is fun.
2. I have good feelings toward science.
3. I enjoy science courses.
4. I really like science.
5. I would enjoy being a scientist.
6. I think scientists are neat people.
7. Everyone should learn about science.

The following revised Simpson and Troost *Attitude Questionnaire* subscales were used for this study. The questionnaire was modified by using a subscale that included student attitudes toward science as a career. The instrument also required revision because of irrelevant items that we decided to delete. The items that were deleted were those that asked questions of a personal nature in regard to the school principal, the teacher or the school itself.

Attitude Toward Science:

1. I would enjoy being a scientist.
2. I enjoy science courses.
3. Science is fun.
4. I have good feelings toward science.
5. I think scientists are neat people.
6. Everyone should learn about science.
7. I really like science.

Science Anxiety:

1. Science makes me feel as though I'm lost in a jungle of numbers and words.
2. I would probably not do well in science if I took it in college or University.
3. My mind goes blank when I am doing science.
4. Science tests make me nervous.

Science As A Career:

1. I would enjoy being a scientist.
2. I think scientists are neat people.
3. I think I am capable of becoming an engineer, scientist or doctor.

General Self Concept:

1. I feel I have a number of good qualities.
2. I consider myself a good science student.

Family Science:

1. My parents help me with my science homework.
2. My parents expect me to do well in school.
3. My brothers and sisters like science.

Achievement Motivation:

1. The students work together well in this class.
2. I try hard to do well in science.
3. I always try hard, no matter how difficult the work.

**THE VIEWS ON SCIENCE-TECHNOLOGY-SOCIETY
(VOSTS) STATEMENTS**

The VOSTS statements (Appendix C) were created by Aikenhead and Ryan to assess student views on science, technology and society (STS) topics. This instrument deviates from the more typical Likert - type response format. It is a Canadian Instrument and a stratified sample of grade twelve (17 year old) Canadian students played a major role in the development of VOSTS. The Views on Science-Technology-Society statements are in actuality student ideas or 'student positions' catalogued in a logical way. The VOSTS inventory item pool is comprised of 114 statements which have been designed to monitor students' viewpoints of STS topics. The assessment battery follows an empirically based multiple choice mode. Students are to select the 'student position' that is most similar to their own. The instrument itself is available in both English and French and Anglophone and Francophone norms have been established. This study has used those items that could provide insight and information in regard to student attitudes and toward science and technology.

VOSTS came about because of the introduction of the new science-technology-society (STS) curriculum. The new curriculum required a new instrument for assessing student views on STS topics. The content of VOSTS is based upon literature that discusses the social and technological contexts of science. Books from Aikenhead (1985), Barnes and Edge (1982), Fleming (1987), Gauld (1982) and Ziman (1980, 1984) along with articles such as Science, Technology, and Human Values and the Bulletin of Science, Technology and Society have provided foundation information. The conceptual scheme of VOSTS is broad and includes the following topics.

VOSTS Conceptual Scheme

1. Science and technology.
2. Influence of society on science and technology.
3. Influence of science/technology on society.
4. Influence of school science on society.
5. Characteristics of scientists.
7. Social construction of technology.
8. Nature of scientific knowledge.

The VOSTS format has been selected for this study because of the weaknesses that Aikenhead has identified with Likert-scales.

THE RESEARCHER-CONSTRUCTED STUDENT BACKGROUND QUESTIONNAIRE

The researcher-constructed Student Background Questionnaire included nineteen items and can be found in Appendix D. Questions such as *What is science?*, *What is technology?*, *Why do you like science?*, *Why don't you like science?*, *What career do you wish to pursue?*, and *What do you think should be taught in science classes?* were included in the survey. The battery was administered to ascertain information that would provide explanations to some of the questions that had been responded to on the Likert-scale instruments. For example: Item #41 (Appendix B) from the

Simpson and Troost instrument asks students to respond to "I really like science". When students respond the researcher has a degree rating of how much the student likes science, but does not know why the student likes science. This questionnaire was included as an assessment device to help gain knowledge in regard to the "whys" the "why nots" and the "whats" of student attitudes toward science and technology.

STUDENT INTERVIEWS

The final data gathering strategy was that of student interviews. Interviews were used in an attempt to uncover student attitudes toward science and technology and to probe for the sources of those attitudes. Aikenhead (1988) compared assessment methodology and determined that the interview offered the most lucid and accurate data. It was thought that the interviews would support and possibly clarify data that had been obtained from the other assessment devices, while at the same time offering background as to where the student responses had come from.

A liability of student interviews was the time that would be required to gather and analyze the data. For this reason only three students from each grade level were selected to participate in the interview component. The interview sample was selected after the data from the other assessment devices had been analysed. This allowed the researcher to access one student who liked science, one student who did not like science and one student who neither liked nor disliked science to interview. Questions for the interviews were taken from the researcher-constructed questionnaire. (Appendix D)

THE PROCEDURE

Once the choice of research instruments had been made, permission to use the instruments was sought and obtained from Yager and Penick and Simpson and Troost, and Aikenhead. Next, permission was sought and obtained from the Research Division of The Edmonton Public School Board to

conduct the study in their schools. The principals of the schools that were to be involved were contacted and permission was given to use two classes of grade three students, two classes of grade eight students and three classes of grade eleven students. Teachers of the classes that were to participate in the study gave permission for the study to take place in their respective classrooms. Preliminary contact took place with the teachers to arrange for a time when I could explain each of the questionnaires to them. A date was then set for when the questionnaires could be administered. Teachers were asked to explain to their students the purpose of the study and allow them the choice to refuse to participate if they so chose. The teachers reported to the investigator that all students were in favour of participating in the study. At an appointed date and time the classroom teachers presented the students with the instruments, one at a time, and explanations as to how to complete each of the instruments. The researcher was available to answer any questions that arose along the way.

First, students completed the Yager and Penick *Preferences and Understandings* survey. Second, they completed the Simpson and Troost *Attitude Questionnaire*. Third, they completed the researcher-constructed Student Background Questionnaire. Fourth, the grade eight and grade eleven students completed the *VOSTS* statements. The surveys were then collected and the data entered into the computer at the Faculty of Education Research Centre. The results were then analyzed and three students from each grade level were selected to be interviewed. Individual twenty minute interviews were then conducted with one student who liked science, one student who did not like science and one student who seemed to neither like or dislike science from each of the three grade levels.

The study was administered during one week in May of 1991. Grade three and grade eight students completed the questionnaires over two days. A forty minute block of time was set aside on each of the days for them to respond to the questionnaires. Grade eleven students completed the instruments over an eighty minute time period. Any student requiring additional time was provided with the extra time necessary. Students made

informal comments to the researcher both before and after the administration of the questionnaire.

One of the common comments mentioned by students was that there were too many 'things' to fill out. Other informal and formal comments follow in Chapters Four and Five. Chapter Four will discuss the findings from the Yager and Penick and the Simpson and Troost assessment devices. Chapter Five will present the findings from the *VOSTS* statements, the Student Background Questionnaire and the Interviews.

CHAPTER IV

STUDENT ATTITUDES OF THE RELATIONSHIP BETWEEN SCIENCE, TECHNOLOGY AND SOCIETY ISSUES

INTRODUCTION

The Edmonton results gathered from the Yager and Penick *Preferences and Understandings Instrument* (Appendix A) and The Simpson and Troost *Attitude Questionnaire* (Appendix B) are presented and discussed in this chapter. Data collected from the aforementioned instruments was compiled and the information was then entered into the computer. Results were then generated, an item analysis completed and correlations calculated between subscales. These results indicated that grade three and grade eleven students possess very positive attitudes toward science, with grade eight students reporting somewhat less positive attitudes. This is interesting to note as the Iowa results, reported by Yager and Penick, showed that as grade level increased, attitude toward science decreased. This Chapter will thematically present the Yager and Penick Instrument research findings from the Edmonton sample and, when available, discuss and compare results from the Iowa sample. Edmonton results, from the Simpson and Troost Attitude Questionnaire, will also be presented within the thematic discussion sections. Finally, subscale correlations from the Yager and Penick and the Simpson and Troost instruments will be presented. This chapter will show the results from a Canadian sample and an American sample. Results from the studies will be discussed and significant differences between them noted.

STUDENT PERCEPTIONS OF THEIR SCIENCE CLASSES

Table 1 indicates the perceptions of students concerning their science classes. Science classes were perceived to be most fun by grade three students (82%). This drops to 58% for grade eight students and then increases

increases to 74% for grade eleven students. This study found that there was a decline in the number of students who thought their science classes were fun between the third and eighth grades and improvement by grade eleven. The findings from the Edmonton study are somewhat different than those found in Iowa. The Iowa study reported that 64% of nine year olds perceived science classes as being fun. This figure dropped to 40% for thirteen year old students, 25% for seventeen year old students and to only 2.0% for young adults. It should be noted that the young adult sample, that participated in the Iowa study, lacked many of the top students who often attend college and who do not return to their high school communities to pursue their careers. The Iowa study found that the more years students were enrolled in science courses, the less they liked it.

The Edmonton findings are similar to those found by Barrington and Hendricks (1988), from the University of Wisconsin. Barrington and Hendricks measured students attitudes toward science and found that the most favourable attitudes toward science were expressed by third graders, next most favourable by eleventh graders and next most favourable by eighth graders. They also identified that there were significant differences between grades in regard to their attitudes concerning science, science classes, science teachers, the value of science and what it is like to be a scientist. It should be noted that both the Iowa study and the Barrington and Hendricks study surveyed grade seven students, whereas this study surveyed grade eight students.

When Edmonton students were asked about whether science classes were interesting the high school sample was the most positive (86%), with third graders (79%) reporting the next most positive results and eighth graders (67%) reporting the least positive results. 85% of third grade Edmonton students thought their science classes were exciting. A major decline occurs in the results reported by the grade eleven (50%) and the grade eight sample (42%).

When Iowa students responded to whether or not they found their science classes to be interesting or whether or not they found their science classes to be exciting the "as age increases student attitude toward science

decreases" response pattern emerged. 84% of third graders described their science classes as being interesting. This figure decreased to 51% for seventh graders, 46% for eleventh graders and 21% for the young adult population. 51% of third graders thought their science class was exciting. This dropped to 43% for the junior high sample, 40% for the high school sample and 29% for the young adult sample.

Most Edmonton third grade students (76%) report that their science classes make them feel successful. Such a report drops to 47% for eleventh grade students and 40% for eighth grade students. Edmonton students also indicated that they felt comfortable in the science classroom. Grade eleven students (75%) identified that science classes made them feel curious. This value drops to 69% for grade eight students and 52% for grade three students.

Yager and Penick also assessed how science classes made students from Iowa feel. 59% of the grade three population reported that science classes made them feel successful. This figure decreased to 40% for seventh grade students, 30% for eleventh grade students and 20% for the young adults.

Yager and Penick asked Iowa students if their science classes made them feel curious. 40% of third graders felt their science class made them feel curious. 24% of seventh grade students, 20% of grade eleventh grade students and 21% of young adults found that their science classes stirred their curiosity.

Iowa students were also asked to respond as to whether or not science classes made them feel uncomfortable. 6.0% of the grade three students revealed that they felt uncomfortable in their science class. This figure increased to 22% for seventh graders, 20% for eleventh graders and 31% for the young adult population.

Yager and Penick concluded, from their Iowa study, that the optimistic, success-oriented viewpoint of the third grader dies away quickly over the eight additional years it takes to reach grade eleven. An additional eight years that sees students competing in an arena where the teacher always knows more than that of the student. Over the eight years the student also witnesses an increase in the amount of curriculum being presented by teacher lecture,

increased reading and an increased emphasis on formal student evaluation. Yager and Penick comment that in order to eliminate student acquisition of negative attitudes toward science teachers must give them useful ideas, information and skills. Teachers must teach science dynamically, as it exists in the real world; science that is useful now and in the future. Science education must meet the needs of our students and when this goal is realized schools will see increased enrolments, more positive viewpoints, and enhanced scientific literacy. (Yager and Penick, 1986, p. 362)

Yager and Penick liken the teaching profession to that of being a physician. "as a physician must know how to practice medicine a teacher must know how to teach science." (1986, p. 326) Teaching must include communicating science and its nature through the entire classroom climate, the teaching strategy, content selected and expectations presented.

The results from the Simpson and Troost Attitude Questionnaire in regard to the item "Science is fun" demonstrated similar findings to that of the Edmonton results from the Yager and Penick instrument. The Simpson and Troost Questionnaire results (Table 2) show that science is thought to be most fun by third graders (88%). 71% of eleventh graders and 62% of eighth graders thought of science as being fun. The item "I enjoy science courses" shows that 76% of grade eight students, 74% of grade eleven students and 58% of grade eight students enjoy their science courses. This pattern of grade three's and grade eleven's being closer to one another and grade eight students reporting a lower score is common for this research.

When students were to identify whether they "really liked science" the grade three student results were consistent in being the most positive of the group. 85% of them responded that they really liked science. The grade eleven student results (64%) fell behind those from grade three and the grade eight results (52%) fell behind those reported by the grade eleven students. It should be noted that the grade eleven findings were not nearly as close to the grade three responses for this item as has been the case. 74% of grade eleven pupils had reported that they enjoyed their science courses and 71% of them responded that they thought that science was fun but only 64% of grade

TABLE 2

Percentage Frequency of Various Age Groups' Perceptions of Their Science Classes.
(Simpson and Troost Instrument)

Sample/Descriptor	THIRD GRADE			EIGHTH GRADE			ELEVENTH GRADE		
	N=23	N=10	N=33	N=23	N=22	N=45	N=31	N=27	N=58
	Male	Female	Total	Male	Female	Total	Male	Female	Total
I enjoy Science Courses. (Item#7)	74	80	76	78	36	58	74	74	74
Science is fun. (Item#12)	87	90	88	83	41	62	71	70	71
I have good feelings toward science. (Item#23)	78	80	79	78	46	62	77	67	72
Everyone should learn about science. (Item#35)	78	80	79	91	77	84	71	82	76
I really like science. (Item#41)	83	90	85	73	32	52	68	59	64

eleven students reported that they "really liked science".

It is interesting to note that for item number 35 (Table 2) which states "Everyone should learn about science" that the grade eight students reported the highest percentages (84%). This, when compared to the other findings, would indicate that even though some of them appear to not enjoy their science courses they appear to still value science as a curricular area of study.

Contrary to the Yager and Penick study conducted in Iowa attitudes toward science do not appear to decline as students grade level increases. Instead, grade three and grade eleven students report very positive attitudes to science with the grade eights being the least positive. Edmonton science students found science classes to be fun and interesting and they felt that their science experience made them feel curious. Understandably students who enjoy their science classes and feel curious about them will attend and be more interested in participating in their science class. They also report that they are comfortable within the science classroom. If students are at ease in the science classroom they will undoubtedly experience less anxiety and, thus be able to concentrate more on the activities that take place within the science classroom.

Given the opportunity to express in their own words why they liked or disliked science (Appendix F, Item 3) the majority of grade three students reported that they liked science. The most common responses provided as to why they liked science were "because it is fun" and "because we eckperemet whith stufe". One of the male students interviewed identified that he liked when you mixed chemicals and they changed to cool colours.

The grade eight males tended to like science whereas six out of the twenty two grade eight females reported that they did not like science. Reasons for liking science were that "science is interesting and may help in the future", "it is an interesting subject area and you can exparement", and "because you learn a lot about the earth's surprises". Few grade eight students did not like science and the reasons they provided were "I find it boring", "because I don't get to dissect anything" and "its gross".

Grade eleven students liked science because "it is interesting". A male physics student reported during an interview that "I'm interested in the world

around me and I believe that science has the potential to improve our quality of life and solve the various problems facing the world". When asked how he felt science could improve our quality of life he replied "science will help us live longer and healthier lives, science will find a cure for AIDS, and science and technology will solve the environmental problems and the world hunger problems that we are and that we will be facing". Grade eleven students also identified that "it is a hands on subject and that makes it fun to learn". A grade eleven female responded "I like science because it's neat, you get to learn some interesting things and go on field trips and do labs".

The majority of Science 24 males liked science "because I've always liked to do experiments" and because I "like to study why and how things happen in the world". This may be because many male students in Science 24 and Science 14 enjoy practical, hands-on activities; hands-on work. This is evident in their future career choices as well. The careers they were interested in pursuing were Carpentry, Mechanics, Engineering and Plumbing.

Students find the science curriculum to be of interest to them. They clearly enjoy learning about "how" and "why" things happen in the world around them. It is evident from the information gathered using the questionnaire that students from all grade levels undoubtedly like the practical, hands-on, experimental nature that exists within the science classroom.

When grade three students were asked what they thought should be taught in science classes (Item 17) they replied "chemistry", "electrecety", "magnetiks" and "cuting frogs". Grade eight males wanted "science with more lab work", "dissections", and "human anatomy" presented in their science classes. Grade eight females were concerned that they be informed about "environmental subjects and the things around, on the trees and ponds like in nature". They also wanted to find out about "things that we will definitely need for the future".

A common thread ran through the grade eleven responses. Their interest was that science classes should cover "science fundamentals, as well

as how it relates to the world, to issues and to the future", they want to know about "the issues that are in today's society". It appears as if they want to know the basics and how those basics relate to the real world; to the future.

Male science 24 students suggested ideas that were hands-on in nature such as wanting science classes to teach "gas ratios to improve performance" and "carpentry".

From the grade eight and grade eleven responses it is apparent that the students want a science curriculum that is practical and relevant. Students want their science teachers to relate science "to life", "to everyday things", and "to the future".

The final item of the Student Background questionnaire (Item 19) asked students to identify how science teachers could make the science classroom more interesting for science students. All grade levels recommended that science classes should include more "hands on activities" and "more experiments". Students suggested that by "being funny and doing fun stuff", by the teacher "being creative", and by having a teacher who taught with "oomph and excitement" the science classroom could become a better learning environment. When the grade three student who suggested "being funny and doing fun stuff" was asked to elaborate she responded that it was important for teachers to have a sense of humour and when they make you laugh they help you remember more". She explained that "doing fun stuff" was "playing science games, going on field trips to the Provincial Museum to see the dinosaur display, going to the Space Science Centre and by working on cool experiments like mixing two liquids together and watching them for a minute and then 'poof' they change colour ... just like magic!"

One grade three boy wanted the school to "try to get more people that know lots about science". Science was his favorite subject and he said that "I wish we got to spend more time to science stuff in school". When I asked him what kinds of science stuff he would like to do he replied "more mixing chemicals", more experiments, more science puzzles and more science learning".

A young man from Science 24 reckoned that science teachers should

"let students dissect human hearts and other organisms". He reasoned that in order to "better know about how people work you have to look at their parts just like you have to look at, and work with car parts to understand how a car works".

Students from all three grade levels commented on the actual classroom decor as being something that could be worked on to make the classroom a more interesting place for science students. Comments such as "decrating it", "more displays of scientific stuff", "paint it one uniform colour" and "have more interesting posters" illustrate the importance that the actual physical learning environment has for some of our students. Those students who are visual learners may well require the appropriate visual learning space.

Students mentioned that they would like "more concentration on social issues", separate classes for those who are especially interested", "more activities and demonstrations", "more field trips", "more interaction between students and between students and teachers", more "talk about how things relate to life" and more "audio-visual such as Nova and National Geographic". A suggestion was also made that teachers should "find different ways to distribute the knowledge besides lectures and notes".

STUDENT PERCEPTIONS OF SCIENCE AS A CAREER

The Yager and Penick *Preferences and Understandings* instrument also includes items that asks students science career related questions. The following information was collected from those items and is presented in Table 3. Comparative information from the Yager and Penick study was not available, thus only the results from the Edmonton sample have been presented.

When Edmonton students were asked if they felt that being a scientist would be fun grade three students were the most optimistic 64% of them thought that becoming a scientist would be fun. This number drops to 40% for the grade eight students and increases to 52% for the grade eleven population.

TABLE 3

Percentage Frequency of Various Age Groups' Perceptions of Being a Scientist
(Yager and Penick Instrument)

Sample/Descriptor	THIRD GRADE			EIGHTH GRADE			ELEVENTH GRADE		
	N=23	N=10	N=33	N=23	N=22	N=45	N=31	N=27	N=58
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Do you think that being a scientist would be fun? (Item#26)	65	60	64	44	36	40	52	52	52
Do you think that being a scientist would make you rich? (Item#27)	35	40	36	52	32	42	42	11	28
Do you think that being a scientist would me alot of work? (Item#28)	65	60	64	78	91	84	100	93	97
Do you think that being a scientist would be boring for you? (Item# 29)	4.3	10	6.1	30	32	31	40	37	39
Do you think that being a scientist would make you feel important? (Item#30)	61	50	58	57	68	62	74	67	71
Do you think that being a scientist would make you feel lonely? (Item#31)	0.0	10	3.0	8.7	23	16	29	30	29

On the other hand, students were questioned in regard to whether or not being a scientist would be boring. Only 6.1% of grade three, 31% of grade eight, and 39% of grade eleven students had the impression that being a scientist would, in fact, be boring.

There was little question in the minds of our young scholars when asked if they thought being a scientist would be a lot of work. Here the majority of eleventh graders responded (97%) that in their minds being a scientist would be a great deal of work. This statistic correlates with the interview information collected from the high school students. They reported that they felt that to become a professional in a scientific or technological field took longer than other fields, that the schooling would be more difficult and that you would have to work longer hours once you entered the work force. 64% of the third graders and 84% of the eighth graders also felt being a scientist would be a great deal of work.

Eighth graders were the most optimistic in thinking that becoming a scientist would make you rich. 42% of eighth graders compared to 36% of third and 28% of eleventh graders thought that a scientific career would be financially rewarding. Some students obviously do not see the income of a scientist as being attractive in nature.

From Table 3 one may suggest that students might avoid scientific careers because of the work load associated with a profession of this nature. It does not appear as if they would avoid a scientific career because they think it would be boring or that they would find it to be a lonely professional path to choose. Students have identified that they believe that a career as a scientist would make them feel important. (Table 3, Item 30) The grade eleven sample, in particular, (71%) responded favourably to this item. This would indicate that the "importance" or the value of this profession is recognized by the students.

The Simpson and Troost Attitude Questionnaire, like the Yager and Penick instrument, includes career related items. Students were asked if they would enjoy being a scientist (Table 4, Item 1). The results indicate that most do not think they would enjoy a career of this nature. Only 46% of grade three, 38% of grade eleven and 29% of grade eight students replied that being a

TABLE 4

Percentage Frequency of Various Age Groups' Perceptions of Being a Scientist
(Simpson and Troost Instrument)

Sample/Descriptor	THIRD GRADE			EIGHTH GRADE			ELEVENTH GRADE		
	N=23	N=10	N=33	N=23	N=22	N=45	N=31	N=27	N=58
	Male	Female	Total	Male	Female	Total	Male	Female	Total
I would enjoy being a scientist. (Item#1)	44	50	46	26	32	29	42	33	38
I think scientists are neat people. (Item#27)	83	90	85	57	59	58	52	67	59
I think I am capable of becoming an engineer, scientist or doctor. (Item#34)	57	50	55	61	68	64	84	44	66

scientist would be enjoyable. Results using the Yager and Penick instrument follow a similar response pattern (Table 3, Item 26)

A second career related item asked students if they thought that scientists were "neat people". The results from this item were more positive with 85% of grade three students, 58% of grade eight students and 59 % of grade eleven students responding in a favourable manner. These results indicate that grade eleven students are not overwhelmingly convinced that scientists are neat people. Maybe if we exposed our science students to more scientists, through mentorships and guest speakers, they would feel differently.

The third item in the career subscale had students respond to if they felt they were capable of becoming an engineer, scientist or doctor. Looking at Table 4 one can see that as grade level increased so did the number of people who thought they could indeed become a professional in one of the aforementioned scientific or technological fields. One should note that 84% of male grade eleven students, compared to 44% of female grade eleven students, were confident that they could succeed in the aforementioned fields.

The students surveyed have a relatively realistic view of science as a career. Students identify that they believe that being a scientist would be a lot of work but they do not think that being a scientist would be boring. The majority of Edmonton students do not see themselves as pursuing a scientific career. The researcher-constructed Student Background questionnaire asked students what careers they might be interested in pursuing. Some of their responses follow.

Students were asked (Appendix, Item 15) what career/careers they were interested in pursuing. Six grade three males were interested in pursuing science related careers. Two wanted to be a "sciantict", one a "Doctor", one a "Vet" and one and "Ostrnot". Other careers of interest were becoming "a Pilete", a "Police Man" and a "Detective".

Five grade three females wanted to "be a Teacher" and two wanted to be "a Lawyer". The only science related careers mentioned were that of being a "Doctor" or a "Nurse". These careers were each mentioned once.

Grade eights identified a greater variety of career interests and many of

them tie into the fields of science and technology. The males were interested in becoming "a Doctor" (being a Doctor was mentioned seven times whereas the careers that follow were listed only once each), a "Lab Technician", a "Dentist", a "Neuro-Surgeon", a "Marine Biologist", a Forest Ranger", a "Forest Conservationist" and an "Engineer". Pursuing a "law Career" was mentioned twice and four students wanted to pursue professional sports. The sports referred to were that of Hockey and Basketball.

Grade eleven students identified an interest in pursuing a variety of scientific and/or technological fields. Males want to become Marine Biologist, Pharmacists, Engineers, Computer Engineers or Science Teachers. Females were interested in careers that have been traditionally dominated by females such as Nursing and Social Work. They also identified Occupational Therapy and Paramedics as being careers of interest.

I questioned the grade eleven students as to why they did not want to become Medical Doctors or Dentists and they responded that it took too long to get out into the working world" and "it took too much hard work and effort to become professionals of this nature". They identified that four years of post-secondary education was more than enough. They also suggested that once you secure a job in a scientific or technological field you have to continually work harder that you would have to in a non-scientific or non- technological field. 96.6% of grade eleven students from this study reported, when they completed the Yager and Penick inventory, that they thought being a scientist would be a great deal of work. (Table 3,Item 28) The interviews clearly support the Yager and Penick inventory data.

STUDENT PERCEPTIONS OF THEIR SCIENCE TEACHERS

Studies from Iowa, in particular at the grade eight and grade eleven level, report that they don't feel teachers like students to give their own ideas. (Table 5, Item 19) Students from Edmonton report quite different findings. They believe that their teachers like their students to present their own ideas. Grade eight and grade eleven students from the Edmonton sample feel that their own

TABLE 5

Percentage Frequency of Various Age Groups' Perceptions of Their Science Teachers (Yager and Penick Instrument)

Sample/Descriptor	THIRD GRADE				EIGHTH GRADE				ELEVENTH GRADE			
	N=23		N=10		N=23		N=22		N=31		N=27	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ask frequent questions. (Item#7)	39	50	42	88	48	55	51	75	71	56	64	79
Likes you to ask questions. (Item#8)	57	20	46	58	65	77	71	55	74	74	74	52
Likes you to give your ideas. (Item#9)	61	60	61	66	78	91	84	44	77	82	79	40
Really likes science. (Item#10)	48	60	52	35	78	86	82	78	93	89	91	82
Makes science exciting. (Item#11)	65	80	70	72	44	14	29	51	45	59	52	43
Knows much about science. (Item#12)	74	80	76	69	91	86	89	61	97	96	97	81
Admits to not knowing. (Item#13)	44	20	36	44	78	77	78	22	65	89	76	14

opinions are of value. If one feels that their opinion is considered to be worthwhile then, more than likely, they will offer their opinions and participate more frequently in classroom discussions. This ultimately will also make students, from Edmonton, feel more comfortable within the science classroom.

Table 5 reports results from the perceptions of science teachers subscale. Item number ten, from the Yager and Penick Instrument, asks students to respond to *"Does your teacher really like science?"*. Elementary school teachers in comparison to junior high and high school science teachers do not appear to like science much. Could elementary science teachers appear to look like they dislike science because they commonly lack the academic background for teaching science? Could it be that the lack of academic background makes them uncomfortable when presenting science curriculum? The fact that only 52% of grade three students thought their teachers really liked science has certainly not had a negative effect on student attitudes in regard to their science classes, for 82% thought their science classes were fun and 85% thought science classes were exciting. For this item the Yager and Penick- Iowa findings demonstrate the same response trend as does this study, that being that fewer grade three students perceive that their teachers really like science.

The Yager and Penick study, in contrast to our results, found teachers in general to be question askers. (Table 5, Item 7) The numbers from this study indicate that on average about half of the students from each grade level felt that science teachers ask frequent questions. 74% of grade eleven and 71% of grade eight students felt that their teachers liked when they asked questions. Only 46% of grade three students felt this way. Grade eight and grade eleven Edmonton Students report that their teachers like them to ask questions. This undoubtedly will make students feel more at ease with asking questions in their science class.

Fewer than half of the grade eight students and only half of the grade eleven students think that science teachers make their science classes exciting. (Table 5, Item 11) This is relatively disturbing when you take into account that seventy percent of the elementary students think that their science teachers

make science exciting. Could it be that the teachers who "appear to like science" and who have possibly had more science education make science less exciting?

Grade eight and grade eleven Edmonton teachers are not afraid to admit not knowing. (Table 5, Item 13) This quality demonstrates an excellent scientific attitude for students as it presents science in a less authoritative fashion. A teacher can admit to not knowing and demonstrate, for their students, that they are willing to seek the answer. For students this models that it is okay to not always have the correct response right there on the "tip of your tongue". Teachers can also show that they might not know the answer, but that they are willing to find out what the answer is.

STUDENT PERCEPTIONS OF THE VALUE OF SCIENCE STUDY

The following discussion presents information from questionnaire items that asks students if they feel that the study of science is worthwhile. Item 22 (Table 6) tenders the question, "*Are the things you learn in science useful to you when you are not in school?*". Most students, from all grade levels, felt that what they learned in science class was useful to them outside of school. 63% of grade three, 64% of grade eight, and 71% of grade eleven students responded in this manner.

Item 24 is similar to item 22 (Table 6) and asks, "*Do you feel that the science you study is generally useful to you?*" 72% of grade three, 67% of grade eight and 73% of grade elevens responded that science was generally of use to them. It is interesting to note that 82% of the grade eleven females thought, in comparison to 65% of males, that the study of science was useful.

Students were asked (Table 6, Item 23), "*Do you think that knowing science will help you in the future?*". All three grade levels, grade 3 (79%), grade 8 (82%), grade 11 (80%), believed that knowing science would help them in some way in the future. 89% of grade eleven females though knowing science would help them in the future.

Items 22, 23, and 24 (Table 6) relate to whether or not students believe the study of science is a useful and worthy endeavour. The student responses reveal that students do find science curriculum useful and do think that knowing science will be of value to them in the future. In particular, the grade eleven female population appears to be convinced that studying science is beneficial.

Item 38 (Table 6) inquires, "*Do you use information you learn in science in situations outside of school?*". The response trend for this item is as age increases so does ones ability to use the science information that they have learned in school. 45% of grade three, 49% of grade eight and 73% of grade eleven students used information learned in science class in situations outside of the school environment. The grade eleven results are encouraging because the Student Background Questionnaire identifies that students want information that is "useful in daily life". It appears as if the grade eleven sample finds that their science is of use to them in their daily lives.

Item 37 (Table 6) asks, "*Does technology effect your daily living?*". It was identified on the student background questionnaire that grade three students had difficulty with the word technology. Understandably the same difficulty would have existed when it came time for them to respond to this item that asks about technology. Most grade three students responded that they did not know if technology effected their daily living. Grade eight (73%) and grade eleven (95%) students did not have difficulty responding to this item and appeared to have strong feelings that technology did indeed effect their daily lives. When a student was asked in a Student Interview how technology effected their daily living a grade eleven male responded that it "provides people with things like microwaves and compact discs that make life easier and more interesting". A grade eleven female responded that technology has provided us with devices like X-ray machines and the Canada Arm that allow us to make the world a better place to live".

Students felt that what they learned in science class was useful to them outside of school. They also believe that their study of science will be useful to them in their future endeavours. Grade eight and grade eleven students found that technology effected their way of living by "making the world a better place

TABLE 6

Percentage Frequency of Various Age Groups' Perceptions of the Value of Science/Technology
(Yager and Penick Instrument)

Sample/Descriptor	THIRD GRADE			EIGHTH GRADE			ELEVENTH GRADE		
	N=23	N=10	N=33	N=23	N=22	N=45	N=31	N=27	N=58
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Are the things you learn in science useful to you when you are not in school ? (Item# 22)	65	60	63	70	59	65	61	82	72
Do you think that knowing science will help you in the future? (Item# 23)	78	80	79	87	77	82	71	89	80
Do you feel the science you study is generally useful to you? (Item#24)	74	70	72	74	59	67	65	82	74
Does technology effect your daily living? (Item#37)	13	30	22	78	68	73	94	96	95
Do you use information you learn in science in situations outside of school? (Item#38)	39	50	45	57	41	49	68	78	73

to live".

SCIENCE COURSES IN COMPARISON TO OTHER COURSES

The Yager and Penick *Preferences and Understandings* questionnaire also asks students to select their favourite subject from a list of core and option courses. The courses included in the list are language arts, social studies, mathematics, science, art, physical education, music and foreign languages. The second item has students identify, from the same list, their second favourite subject and the third item has students select, again from the same list of subjects, their least favourite subject. Tables 7, 8 and 9 document the findings from these items.

In grade three (Table 7) science was mentioned as first or second favorite choice by 48% of the students, with only art being more popular at 64%. In grade eight (Table 8) science was mentioned as first or second choice by 29% of the students, with physical education (62%) and math (42%) being more popular. In grade eleven (Table 9) science was listed as first or second choice by 43% of the students, although fewer pupils attending high school have the opportunity to take subjects like physical education, art, music, and foreign languages.

From Tables 7, 8, and 9, one can see that science appears to be popular with grade three and eleven students. Science also seems to be somewhat popular for the grade eight students surveyed. The reasons why students related science so highly was pursued in the Student Background questionnaire. Some reasons (Item 3, Appendix F) that students provided when asked why they liked science were that they "find it interesting", they "enjoy doing labs", they like to "understand how things around us come to be, what they are and how they work", and they "like the mysteries and the beauties that life holds". Another reason why students rated science so highly could be that all Edmonton students reported that they value science.

TABLE 7

Grade 3 - Yager and Penick Subject Summary

Item #1 Sex: Male Number 23 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Science</td><td>30</td></tr><tr><td>Physical Education</td><td>30</td></tr><tr><td>Mathematics</td><td>22</td></tr><tr><td>Art</td><td>17</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr><tr><td>Music</td><td>0.0</td></tr><tr><td>Social Studies</td><td>0.0</td></tr><tr><td>Language Arts</td><td>0.0</td></tr></table>	Subject	Percent	Science	30	Physical Education	30	Mathematics	22	Art	17	Foreign Languages	0.0	Music	0.0	Social Studies	0.0	Language Arts	0.0	Item #1 Sex: Female Number 10 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Art</td><td>60</td></tr><tr><td>Foreign Languages</td><td>20</td></tr><tr><td>Science</td><td>10</td></tr><tr><td>Music</td><td>10</td></tr><tr><td>Mathematics</td><td>0.0</td></tr><tr><td>Physical Education</td><td>0.0</td></tr><tr><td>Language Arts</td><td>0.0</td></tr><tr><td>Social Studies</td><td>0.0</td></tr></table>	Subject	Percent	Art	60	Foreign Languages	20	Science	10	Music	10	Mathematics	0.0	Physical Education	0.0	Language Arts	0.0	Social Studies	0.0	Item #1 Sex: Both Number 33 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Art</td><td>30</td></tr><tr><td>Science</td><td>24</td></tr><tr><td>Physical Education</td><td>21</td></tr><tr><td>Mathematics</td><td>15</td></tr><tr><td>Foreign Languages</td><td>6.1</td></tr><tr><td>Music</td><td>3.0</td></tr><tr><td>Social Studies</td><td>0.0</td></tr><tr><td>Language Arts</td><td>0.0</td></tr></table>	Subject	Percent	Art	30	Science	24	Physical Education	21	Mathematics	15	Foreign Languages	6.1	Music	3.0	Social Studies	0.0	Language Arts	0.0
Subject	Percent																																																							
Science	30																																																							
Physical Education	30																																																							
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Item #2 Sex: Male Number 23 Second Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Art</td><td>30</td></tr><tr><td>Science</td><td>26</td></tr><tr><td>Mathematics</td><td>17</td></tr><tr><td>Language Arts</td><td>8.7</td></tr><tr><td>Social Studies</td><td>8.7</td></tr><tr><td>Physical Education</td><td>4.3</td></tr><tr><td>Music</td><td>4.3</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr></table>	Subject	Percent	Art	30	Science	26	Mathematics	17	Language Arts	8.7	Social Studies	8.7	Physical Education	4.3	Music	4.3	Foreign Languages	0.0	Item #2 Sex: Female Number 10 Second Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Art</td><td>40</td></tr><tr><td>Science</td><td>20</td></tr><tr><td>Mathematics</td><td>20</td></tr><tr><td>Social Studies</td><td>10</td></tr><tr><td>Physical Education</td><td>10</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr><tr><td>Music</td><td>0.0</td></tr><tr><td>Language Arts</td><td>0.0</td></tr></table>	Subject	Percent	Art	40	Science	20	Mathematics	20	Social Studies	10	Physical Education	10	Foreign Languages	0.0	Music	0.0	Language Arts	0.0	Item #2 Sex: Both Number 33 Second Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Art</td><td>33</td></tr><tr><td>Science</td><td>24</td></tr><tr><td>Mathematics</td><td>18</td></tr><tr><td>Social Studies</td><td>9.1</td></tr><tr><td>Language Arts</td><td>6.1</td></tr><tr><td>Physical Education</td><td>6.1</td></tr><tr><td>Music</td><td>3.0</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr></table>	Subject	Percent	Art	33	Science	24	Mathematics	18	Social Studies	9.1	Language Arts	6.1	Physical Education	6.1	Music	3.0	Foreign Languages	0.0
Subject	Percent																																																							
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Item #3 Sex: Male Number 23 Least Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Music</td><td>39</td></tr><tr><td>Mathematics</td><td>30</td></tr><tr><td>Language Arts</td><td>13</td></tr><tr><td>Art</td><td>8.7</td></tr><tr><td>Social Studies</td><td>4.3</td></tr><tr><td>Foreign Languages</td><td>4.3</td></tr><tr><td>Physical Education</td><td>0.0</td></tr><tr><td>Science</td><td>0.0</td></tr></table>	Subject	Percent	Music	39	Mathematics	30	Language Arts	13	Art	8.7	Social Studies	4.3	Foreign Languages	4.3	Physical Education	0.0	Science	0.0	Item #3 Sex: Female Number 10 Least Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Social Studies</td><td>30</td></tr><tr><td>Mathematics</td><td>30</td></tr><tr><td>Science</td><td>20</td></tr><tr><td>Physical Education</td><td>10</td></tr><tr><td>Music</td><td>10</td></tr><tr><td>Art</td><td>0.0</td></tr><tr><td>Language Arts</td><td>0.0</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr></table>	Subject	Percent	Social Studies	30	Mathematics	30	Science	20	Physical Education	10	Music	10	Art	0.0	Language Arts	0.0	Foreign Languages	0.0	Item #3 Sex: Both Number 33 Least Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Mathematics</td><td>30</td></tr><tr><td>Music</td><td>30</td></tr><tr><td>Social Studies</td><td>12</td></tr><tr><td>Language Arts</td><td>9.1</td></tr><tr><td>Art</td><td>6.1</td></tr><tr><td>Science</td><td>6.1</td></tr><tr><td>Physical Education</td><td>3.0</td></tr><tr><td>Foreign Languages</td><td>3.0</td></tr></table>	Subject	Percent	Mathematics	30	Music	30	Social Studies	12	Language Arts	9.1	Art	6.1	Science	6.1	Physical Education	3.0	Foreign Languages	3.0
Subject	Percent																																																							
Music	39																																																							
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Foreign Languages	3.0																																																							

TABLE 8

Grade 8 - Yager and Penick Subject Summary

Item #1 Sex: Male Number 23 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Physical Education</td><td>61</td></tr><tr><td>Mathematics</td><td>17</td></tr><tr><td>Science</td><td>13</td></tr><tr><td>Art</td><td>4.3</td></tr><tr><td>Language Arts</td><td>4.3</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr><tr><td>Music</td><td>0.0</td></tr><tr><td>Social Studies</td><td>0.0</td></tr></table>	Subject	Percent	Physical Education	61	Mathematics	17	Science	13	Art	4.3	Language Arts	4.3	Foreign Languages	0.0	Music	0.0	Social Studies	0.0	Item #1 Sex: Female Number 22 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Mathematics</td><td>23</td></tr><tr><td>Foreign Languages</td><td>23</td></tr><tr><td>Physical Education</td><td>18</td></tr><tr><td>Social Studies</td><td>14</td></tr><tr><td>Art</td><td>9.1</td></tr><tr><td>Language Arts</td><td>9.1</td></tr><tr><td>Science</td><td>4.5</td></tr><tr><td>Music</td><td>0.0</td></tr></table>	Subject	Percent	Mathematics	23	Foreign Languages	23	Physical Education	18	Social Studies	14	Art	9.1	Language Arts	9.1	Science	4.5	Music	0.0	Item #1 Sex: Both Number 45 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Physical Education</td><td>40</td></tr><tr><td>Mathematics</td><td>20</td></tr><tr><td>Foreign Languages</td><td>11</td></tr><tr><td>Science</td><td>8.9</td></tr><tr><td>Language Arts</td><td>6.7</td></tr><tr><td>Social Studies</td><td>6.7</td></tr><tr><td>Art</td><td>6.7</td></tr><tr><td>Music</td><td>0.0</td></tr></table>	Subject	Percent	Physical Education	40	Mathematics	20	Foreign Languages	11	Science	8.9	Language Arts	6.7	Social Studies	6.7	Art	6.7	Music	0.0
Subject	Percent																																																							
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Subject	Percent																																																							
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Science	9.1																																																							
Foreign Languages	9.1																																																							
Social Studies	4.5																																																							
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Subject	Percent																																																							
Mathematics	33																																																							
Physical Education	22																																																							
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Language Arts	8.9																																																							
Social Studies	4.4																																																							
Art	4.4																																																							
Foreign Languages	4.4																																																							
Music	2.2																																																							
Item #3 Sex: Male Number 23 Least Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Language Arts</td><td>48</td></tr><tr><td>Foreign Languages</td><td>22</td></tr><tr><td>Music</td><td>13</td></tr><tr><td>Social Studies</td><td>8.7</td></tr><tr><td>Art</td><td>4.3</td></tr><tr><td>Science</td><td>4.3</td></tr><tr><td>Physical Education</td><td>0.0</td></tr><tr><td>Mathematics</td><td>0.0</td></tr></table>	Subject	Percent	Language Arts	48	Foreign Languages	22	Music	13	Social Studies	8.7	Art	4.3	Science	4.3	Physical Education	0.0	Mathematics	0.0	Item #3 Sex: Female Number 22 Least Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Social Studies</td><td>23</td></tr><tr><td>Language Arts</td><td>18</td></tr><tr><td>Mathematics</td><td>18</td></tr><tr><td>Science</td><td>18</td></tr><tr><td>Foreign Languages</td><td>14</td></tr><tr><td>Art</td><td>4.5</td></tr><tr><td>Music</td><td>4.5</td></tr><tr><td>Physical Education</td><td>0.0</td></tr></table>	Subject	Percent	Social Studies	23	Language Arts	18	Mathematics	18	Science	18	Foreign Languages	14	Art	4.5	Music	4.5	Physical Education	0.0	Item #3 Sex: Both Number 45 Least Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Language Arts</td><td>33</td></tr><tr><td>Foreign Languages</td><td>18</td></tr><tr><td>Social Studies</td><td>16</td></tr><tr><td>Science</td><td>11</td></tr><tr><td>Mathematics</td><td>8.9</td></tr><tr><td>Music</td><td>8.9</td></tr><tr><td>Art</td><td>4.4</td></tr><tr><td>Physical Education</td><td>0.0</td></tr></table>	Subject	Percent	Language Arts	33	Foreign Languages	18	Social Studies	16	Science	11	Mathematics	8.9	Music	8.9	Art	4.4	Physical Education	0.0
Subject	Percent																																																							
Language Arts	48																																																							
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TABLE 9

Grade 11 - Yager and Penick Subject Summary

Item #1 Sex: Male Number 31 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Physical Education</td><td>33</td></tr><tr><td>Science</td><td>20</td></tr><tr><td>Mathematics</td><td>17</td></tr><tr><td>Social Studies</td><td>13</td></tr><tr><td>Art</td><td>10</td></tr><tr><td>Music</td><td>3.3</td></tr><tr><td>Language Arts</td><td>0.0</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr></table>	Subject	Percent	Physical Education	33	Science	20	Mathematics	17	Social Studies	13	Art	10	Music	3.3	Language Arts	0.0	Foreign Languages	0.0	Item #1 Sex: Female Number 27 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Science</td><td>22</td></tr><tr><td>Physical Education</td><td>19</td></tr><tr><td>Foreign Languages</td><td>15</td></tr><tr><td>Art</td><td>15</td></tr><tr><td>Mathematics</td><td>11</td></tr><tr><td>Language Arts</td><td>11</td></tr><tr><td>Music</td><td>3.7</td></tr><tr><td>Social Studies</td><td>3.7</td></tr></table>	Subject	Percent	Science	22	Physical Education	19	Foreign Languages	15	Art	15	Mathematics	11	Language Arts	11	Music	3.7	Social Studies	3.7	Item #1 Sex: Both Number 58 Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Physical Education</td><td>26</td></tr><tr><td>Science</td><td>22</td></tr><tr><td>Mathematics</td><td>14</td></tr><tr><td>Art</td><td>12</td></tr><tr><td>Social Studies</td><td>8.6</td></tr><tr><td>Language Arts</td><td>6.9</td></tr><tr><td>Music</td><td>3.4</td></tr><tr><td>Foreign Languages</td><td>1.7</td></tr></table>	Subject	Percent	Physical Education	26	Science	22	Mathematics	14	Art	12	Social Studies	8.6	Language Arts	6.9	Music	3.4	Foreign Languages	1.7
Subject	Percent																																																							
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Music	3.4																																																							
Foreign Languages	1.7																																																							
Item #2 Sex: Male Number 31 Second Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Science</td><td>23</td></tr><tr><td>Mathematics</td><td>23</td></tr><tr><td>Art</td><td>19</td></tr><tr><td>Physical Education</td><td>19</td></tr><tr><td>Social Studies</td><td>13</td></tr><tr><td>Language Arts</td><td>3.2</td></tr><tr><td>Music</td><td>0.0</td></tr><tr><td>Foreign Languages</td><td>0.0</td></tr></table>	Subject	Percent	Science	23	Mathematics	23	Art	19	Physical Education	19	Social Studies	13	Language Arts	3.2	Music	0.0	Foreign Languages	0.0	Item #2 Sex: Female Number 27 Second Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Science</td><td>19</td></tr><tr><td>Social Studies</td><td>15</td></tr><tr><td>Language Arts</td><td>15</td></tr><tr><td>Art</td><td>11</td></tr><tr><td>Physical Education</td><td>11</td></tr><tr><td>Music</td><td>11</td></tr><tr><td>Foreign Languages</td><td>11</td></tr><tr><td>Mathematics</td><td>7.4</td></tr></table>	Subject	Percent	Science	19	Social Studies	15	Language Arts	15	Art	11	Physical Education	11	Music	11	Foreign Languages	11	Mathematics	7.4	Item #2 Sex: Both Number 58 Second Favorite Subject <table><tr><th>Subject</th><th>Percent</th></tr><tr><td>Science</td><td>21</td></tr><tr><td>Mathematics</td><td>16</td></tr><tr><td>Art</td><td>16</td></tr><tr><td>Physical Education</td><td>16</td></tr><tr><td>Social Studies</td><td>14</td></tr><tr><td>Language Arts</td><td>8.6</td></tr><tr><td>Music</td><td>5.2</td></tr><tr><td>Foreign Languages</td><td>5.2</td></tr></table>	Subject	Percent	Science	21	Mathematics	16	Art	16	Physical Education	16	Social Studies	14	Language Arts	8.6	Music	5.2	Foreign Languages	5.2
Subject	Percent																																																							
Science	23																																																							
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Subject	Percent																																																							
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DIFFERENCES IN SCHOOL ORGANIZATION BETWEEN SCHOOLS IN IOWA AND SCHOOLS IN ALBERTA

At first glance I was excited and encouraged by the high school results, for after all I am a high school science teacher. As I investigated the matter more thoroughly however I began to note some possible reasons for the differences that arose in particular at the grade eleven level. Those reasons being that science curriculum, at the high school level, is presented differently in the United States than it is here in Canada and that grade eleven is a more stressful year for American students in comparison to that of Canadian students.

Education in the United States is primarily decentralized with each of the fifty states, or communities within the States, setting their own educational policy. Control of science Education in Canada falls under the jurisdiction of the ten provinces and the two territories, so like the United States science educational curriculum is not nationally mandated.

The United States has the same three tier system that we are familiar with here in Alberta; that being kindergarten to grade six, grade seven to grade nine, and grade ten to grade twelve.

Elementary school science, in both Canada and the United States, is taught by the generalist. Quality and quantity of science education varies greatly as many elementary teachers do not have the academic background for teaching science, thus they often teach according to their own strengths or interests.

Junior high school science in both countries is taught as a distinct course at each grade level. Courses commonly include the presentation of several science related disciplines at each grade level. More often than not, science is taught by teachers who have taken University science courses and classes in science methodology.

Grades ten to twelve represent high school in Alberta and senior secondary in the United States. A difference exists between the organization of how science is presented in secondary schools between the States and

Alberta. This difference in curricular organization might influence the results of the surveys.

In Alberta we offer high school students the choice of taking biology, chemistry and physics at each grade level. Some students take all three sciences, in particular those planning on pursuing scientific and/or technological careers, whereas others complete two or even one out of the three. In the United States students are not afforded that choice, instead they study a different science each year. A metaphor used to describe this way of presenting curriculum is that of the "layer-cake" approach. The most common pattern followed is that of grade ten students taking biology, grade eleven students taking chemistry and grade twelve students taking physics. "Most often the science course offered during grade twelve is that of physics but many schools offer a second year of biology or chemistry" instead. (Postlethwaite and Wiley, 1992, pg. 265) It should be noted that in many states students are only required to have two years of upper secondary science credit. As a result, at the grade twelve level, the number of students enrolled in science classes is less than at previous grade levels.

The opportunity to choose which science courses you will take might be why grade eleven students from Edmonton high schools appear to possess more favourable attitudes toward science than grade eleven students from Iowa schools who are not afforded that choice. Gardner (1975) suggests that when students are given a choice in regard to what classes they may take you will observe a relationship between interest and enrolment. The assumption here is that the group phenomenon (enrolment) is an indicator of the psychological phenomenon (attitude).

A second factor that might influence the results of the survey is the possible difference in the amount "stress" experienced by Alberta and Iowa students at the grade eleven level. For students from Alberta grade twelve is the high school year when students experience the greatest amount of stress. This is the year when most students are required to write provincial exams for academic course credit. Marks from these Diploma exams count for fifty-percent of the student's grade. The school/teacher is responsible for the

remaining fifty percent. American students, on the other hand, are more concerned about their achievement in the eleventh grade for University and College entrance exams are often written at this time. Postlethwaite and Wiley (1992) note that many prestigious Universities in the United States accept only those students who have successfully completed University entrance exams. Over the past century entrance exams are said to have had a "powerful influence on how science is taught in American High Schools". (p.263) National exams are not written by American students.

Post-secondary educational opportunities are based upon grade twelve grades in Alberta and grade eleven University or College entrance exams in the United States. The Iowa study surveys grade eleven American students who are under pressure to perform on College entrance exams, whereas the grade eleven Edmonton sample is not experiencing the same stress during grade eleven because their post secondary educational choices are dependent upon their grade twelve grades not their grade eleven grades.

A third factor that might influence the results of the survey is the actual teacher who is teaching the science course. Different teachers provide different learning experiences for their students. How a science teacher presents themselves, and the curriculum, within the science classroom can influence a student attitudes toward science

The educational circumstances experienced by the two grade eleven populations were varied, thus a direct comparison between the high school samples would not necessarily be accurate.

SUBSCALE CORRELATIONS FROM THE YAGER AND PENICK AND SIMPSON AND TROOST INSTRUMENTS

The correlations indicated that, for the most part, the items were likely measuring the same construct. The correlated items behaved acceptably as there were moderate to significant correlations within the subscales and within the total test score. Critical values of the correlation coefficient are as follows: $r > .34$ for the grade three sample, $r > .30$ for the grade eight sample and

$r > .26$ for the grade eleven sample, $p < .05$. (Glass and Hopkins, 1984, pg.549)

From the Yager and Penick item and subscale analysis the following correlations emerge (Tables 10, 11, &12). All three grade levels show a positive correlation between attitude toward science and attitude toward science teacher. ($r=0.65$, grade 3; $r=0.49$, grade 8; $r=0.49$, grade 11, $p < .05$) Germann (1988) reports that teacher and classroom environment play an important role in affecting attitude. The classroom teacher and the classroom environment should strive to nurture student interests, curiosity and student confidence in his/her own ability for these factors seem to be important correlates of student motivation. Mason and Kahle (1989) report that the teacher has been shown to be an influencing factor in affecting student attitudes. Student attitudes are undoubtedly influenced by the classroom teacher. Research findings illustrate that teaching practices can ultimately positively impact student attitudes. Elliott (1971) found that teachers who spent more time in preparation fostered better attitudes among high school physics students. Gardner reports that a study conducted by the University of Bristol found that formal teaching methods, teacher directed activities and little emphasis on objectives or evaluation clustered with a decline in student attitudes. (Gardner, p. 26) Reed (1961) found that teachers who were warm and who could utilize a pupil's intrinsic motivation generated a greater interest in science amongst grade nine students. Gardner (1972/1974a) found that intellectually stimulating teachers (well-organized, achievement motivating, enthusiastic) were associated with more favourable attitudes to physics.

Grade eight results (Table 11) from Yager and Penick present a significant positive correlation between attitude to science teachers and career in science, ($r=0.53$) between attitude toward science teachers and the value of science ($r=0.53$) and as mentioned previously, attitude toward science teachers and attitude toward science ($r=0.49$). The influence of the science teacher appears to be extremely significant at the grade eight level.

A positive correlation also exists at all grade levels between attitude toward science and the value of science ($r= 0.70$, grade 3; $r= 0.62$, grade 8;

TABLE 10
GRADE 3
EDMONTON SAMPLE SUBSCALE CORRELATIONS
YAGER AND PENICK INSTRUMENT

	ATTITUDE TOWARD SCIENCE 1	ATTITUDE TOWARD SCIENCE TEACHERS 2	VALUE OF SCIENCE 3	CAREER IN SCIENCE 4	UNASSIGNED 5	TOTAL TEST 6	GENDER 7
ATTITUDE TOWARD SCIENCE 1	1.00	*.65	*.70	.12	*.50	*.80	-.23
ATTITUDE TOWARD SCIENCE TEACHERS 2		1.00	*.53	.17	*.44	*.79	-.09
VALUE OF SCIENCE 3			1.00	.07	*.59	*.79	-.07
CAREER IN SCIENCE 4				1.00	.16	*.39	.03
UNASSIGNED 5					1.00	*.81	-.32
TOTAL TEST 6						1.00	-.21
GENDER 7							1.00

*p < .05 = .344

TABLE 11

GRADE 8
EDMONTON SAMPLE SUBSCALE CORRELATIONS
YAGER AND PENICK INSTRUMENT

	ATTITUDE TOWARD SCIENCE 1	ATTITUDE TOWARD SCIENCE TEACHERS 2	VALUE OF SCIENCE 3	CAREER IN SCIENCE 4	UNASSIGNED 5	TOTAL TEST 6	GENDER 7
ATTITUDE TOWARD SCIENCE 1	1.00	.49	.62	.55	.60	.80	.11
ATTITUDE TOWARD SCIENCE TEACHERS 2		1.00	.53	.53	.63	.81	-.02
VALUE OF SCIENCE 3			1.00	.50	.49	.75	.19
CAREER IN SCIENCE 4				1.00	.54	.78	-.05
UNASSIGNED 5					1.00	.85	.04
TOTAL TEST 6						1.00	.06
GENDER 7							1.00

* $p < .05 = .298$

TABLE 12
GRADE 11
EDMONTON SAMPLE SUBSCALE CORRELATIONS
YAGER AND PENICK INSTRUMENT

	ATTITUDE TOWARD SCIENCE 1	ATTITUDE TOWARD SCIENCE TEACHERS 2	VALUE OF SCIENCE 3	CAREER IN SCIENCE 4	UNASSIGNED 5	TOTAL TEST 6	GENDER 7
ATTITUDE TOWARD SCIENCE 1	1.00	*.46	*.33	.15	*.43	*.68	-.03
ATTITUDE TOWARD SCIENCE TEACHERS 2		1.00	.26	*.38	*.36	*.74	-.04
VALUE OF SCIENCE 3			1.00	.14	*.38	*.57	-.22
CAREER IN SCIENCE 4				1.00	*.34	*.59	.18
UNASSIGNED 5					1.00	*.79	.15
TOTAL TEST 6						1.00	.04
GENDER 7							1.00

* $p < .05 = .264$

$r=0.32$, grade 11). It makes sense that if you possess a positive attitude toward science that you would, in turn, possess a positive attitude regarding the value of science.

The Yager and Penick grade eight student correlations (Table 11) illustrate that there exists a significant positive correlation between attitude to science and career in science ($r=0.55$, grade 8). The Simpson and Troost grade three, grade eight and grade eleven results (Tables 13, 14 & 15) also show that there is an extremely positive significant correlation between attitude towards science and career ($r=0.82$, grade 3; $r=0.77$, grade 8; $r=0.81$, grade 11, $p < .05$). This stands to reason as one who holds a favourable attitude towards science would likely be interested in a career, or careers that relate to science.

Looking at the Simpson and Troost correlations at the grade three level (Table 13) it is evident that attitude to science correlates with achievement/motivation ($r=0.55$), with career ($r=0.82$), and with general self concept ($r=0.62$). Understandably if a student possesses a positive attitude toward science he/she will in turn probably have an interest in pursuing a career in a scientific field. As well, it makes sense that if one has a positive attitude about science they will probably work harder and achieve more in a science course and if students feel good about themselves they will undoubtedly experience greater success and maintain more positive attitudes toward science.

Gardner states that interest in science apparently originates during the primary school years. To promote that interest he suggests that home background variables such as playing with scientific toys, visiting museums and zoos, reading books and magazines be considered and put into practice. He also suggests that having a parent who can skillfully explain how things work can be a important science role model. Our results indicate the value that having a significant person in one's life who could skillfully explain how things work would be important!

Our grade eight results (Table 14) identify that self-concept correlates positively with career, with attitude to science and with achievement/ motivation. Self-concept possibly correlates with so many subscales because for grade

TABLE 13
GRADE 3
EDMONTON SAMPLE SUBSCALE CORRELATIONS
SIMPSON AND TROOST INSTRUMENT

	CAREER 1	ATTITUDE TOWARD SCIENCE 2	SCIENCE ANXIETY 3	GENERAL SELF- CONCEPT 4	ACHIEVEMENT /MOTIVATION 5	FAMILY SCIENCE 6	UNASSIGNED 7	TOTAL TEST 8	GENDER 9
CAREER	1	1.00	*.60	*.40	.30	*.40	*.49	*.67	.01
ATTITUDE TOWARD SCIENCE	2		1.00	*.62	*.55	*.39	*.77	*.89	.00
SCIENCE ANXIETY	3			*.53	-.33	-.20	-.25	-.33	-.11
GENERAL SELF-CONCEPT	4				*.55	.34	*.67	*.68	-.00
ACHIEVEMENT/ MOTIVATION	5					.30	*.68	*.68	.14
FAMILY SCIENCE	6						1.00	*.57	-.29
UNASSIGNED	7							*.94	-.03
TOTAL TEST	8								1.00
GENDER	9								

* $p < .05 = .344$

TABLE 14
GRADE 8
EDMONTON SAMPLE SUBSCALE CORRELATIONS
SIMPSON AND TROOST INSTRUMENT

	CAREER 1	ATTITUDE TOWARD SCIENCE 2	SCIENCE ANXIETY 3	GENERAL SELF- CONCEPT 4	ACHIEVEMENT /MOTIVATION 5	FAMILY SCIENCE 6	UNASSIGNED 7	TOTAL TEST 8	GENDER 9
CAREER	1.00	.77	-.49	.45	.47	.18	.48	.71	.05
ATTITUDE TOWARD SCIENCE		1.00	-.59	.57	.55	.08	.70	.84	.39
SCIENCE ANXIETY			1.00	-.58	.46	-.03	.26	.30	.33
GENERAL SELF-CONCEPT				1.00	.52	.18	.44	.56	.32
ACHIEVEMENT/ MOTIVATION					1.00	.29	.54	.68	.27
FAMILY SCIENCE						1.00	.05	.31	.02
UNASSIGNED							1.00	.90	.43
TOTAL TEST								1.00	.35
GENDER									1.00

* $p < .05 = .298$

TABLE 15

GRADE 11
EDMONTON SAMPLE SUBSCALE CORRELATIONS
SIMPSON AND TROOST INSTRUMENT

	CAREER 1	ATTITUDE TOWARD SCIENCE 2	SCIENCE ANXIETY 3	GENERAL SELF- CONCEPT 4	ACHIEVEMENT /MOTIVATION 5	FAMILY SCIENCE 6	UNASSIGNED 7	TOTAL TEST 8	GENDER 9
CAREER	1.00	*.81	*.49	*.53	*.29	*.28	*.47	*.69	.23
ATTITUDE TOWARD SCIENCE		1.00	*.48	*.50	*.30	*.51	*.67	*.87	.04
SCIENCE ANXIETY			1.00	*.57	.19	-.03	*.34	-.26	-.23
GENERAL SELF-CONCEPT				1.00	.25	.15	*.36	*.44	*.28
ACHIEVEMENT/ MOTIVATION					1.00	.04	*.27	*.40	-.05
FAMILY SCIENCE						1.00	*.45	*.66	-.15
UNASSIGNED							1.00	*.88	-.04
TOTAL TEST								1.00	-.04
GENDER									1.00

$p < .05 = .264$

eight students this is a time when they are experiencing a transition between childhood and adulthood. Puberty is a time when one must dismiss childhood habits and assume an increasing number of adult responsibilities. Peer pressure, conformity, the desire to be popular, the desire to be accepted, and the desire to be independent are all involved in the formation of a student's personal identity. At this age they are assuming a more complex identity and trying to figure out exactly who they are. As a result of attempting to establish self identity, one finds that self-concept, in particular at this age, is associated with many facets of their existence.

Our results also identify a significant correlation between gender and attitude to science and between gender and self-concept at the grade eight level. Baumrind (1972) points out that socialization practices tend to reinforce the conception that males should be independent, achievement-oriented and dominant, whereas females are to be socially responsible, friendly and cooperative. As this is a time when students are attempting to form some sort of personal identity it is most likely the time when gender differences might surface. It should be noted that the grade three and grade eleven populations do not show the same gender correlations.

Our results from the Simpson and Troost Instrument reveal the following negative correlations. At all three grade levels a negative correlation exists between science anxiety and career. Understandably as science anxiety decreases interest in a science career increases. ($r=-0.60$, grade 3; $r=-0.49$, grade 8; $r=-0.49$, grade 11, $p < .05$)

All three grade levels also show an understandably negative correlation between science anxiety and attitude toward science. Therefore, as science anxiety decreases, attitude toward science increases.

All three grade levels illustrate that science anxiety correlates negatively with general self-concept, thus as science anxiety decreases, general self concept, will in turn, increase.

Grade three and grade eight students provide a negative correlation between science anxiety and achievement/motivation. As science anxiety decreases one will find that student achievement and motivation will increase.

Science anxiety correlates negatively with a number of variables. It is realized that some stress (anxiety) is necessary for totally passive learners do not absorb or retain as much information. It is apparent that less anxiety is definitely the best. If there is less anxiety more student learning will take place and the student will feel more at ease within the science classroom. If students are less anxious they will be more likely to carry on in science. Less anxiety experienced by the student will improve the classroom climate and as classroom climate improves so will the attitudes of the students.

In general the science students surveyed for this study display that they are comfortable within the science classroom and they find their science classes to be interesting. Most students enjoy their science courses to the extent of finding them to be fun. Grade eight females provide the most negative results and appear to be the ones least enjoying their exposure to science curriculum. All groups indicate that they feel that the science they study in school is of value.

Chapter Four has presented and discussed the findings from the Yager and Penick Preferences and Understandings instrument, the Simpson and Troost Attitude Questionnaire, The researcher-constructed Student Background questionnaire and the Student Interviews. Chapter Five will Present the findings from the VOSTS statements and in doing so address student understanding of the relationship between science, technology and society.

CHAPTER V

STUDENT UNDERSTANDING OF THE RELATIONSHIP BETWEEN SCIENCE, TECHNOLOGY AND SOCIETY

The results from the *Views of Science-Technology-Society* statements will be the major focus of Chapter Five. The VOSTS statements were employed to secure additional information about student attitudes toward technology. It was thought that the information accessed via this instrument would be able to support the findings revealed by the Edmonton student responses from the Yager and Penick and Simpson and Troost attitude assessment devices. The Student Background Questionnaire was included and the Student Interviews were conducted to gather explanations for the responses gathered from the other instruments. It was expected that they would also be able to support the findings procured from the aforesaid instruments.

The Yager and Penick, and the Simpson and Troost assessment batteries, discussed in Chapter Four, are Likert-scale instruments. Aikenhead (1988) has identified a number of weaknesses of Likert-scales including the possibility of response bias on the part of those responding, such as a tendency to select extremes. It was decided, because of this possible weakness, that alternative research methodologies would be employed to acquire additional data that could either support or challenge the Likert-scale instrument findings.

The results from the VOSTS statements will be presented in the following manner. Grade eight and grade eleven students responded to twenty six VOSTS statements. The results from all twenty-six items are included in Appendix D. Only ten of the twenty six VOSTS items have been selected for comment. These ten items relate most directly to the original research questions and thus will be discussed at length. A brief summary of the main ideas gleaned from the remaining items will be offered following the presentation of the ten chosen for discussion.

Student responses from the Background Questionnaire and the Interviews will be included within the presentation of the VOSTS statements when appropriate.

VIEWS OF SCIENCE, TECHNOLOGY AND SOCIETY RESULTS

Student attitudes towards science and technology, and their role in society, have been determined in the past usually on the basis of objectively scored items constructed and validated by researchers and other experts (Cooley and Klopfer, 1961; Korth, 1969; and others). These tests usually required students to indicate their agreement or disagreement with a given set of viewpoints. Munby (1982), Aikenhead, Fleming, and Ryan (1987) have suggested that such tests are based on the questionable assumption that students and researchers interpret the various statements in the same way. In fact, student interpretations of specific statements may be quite different, and the student reasons for selecting a particular statement may be quite different from that intended by the researcher. For example, if students were asked to indicate their agreement with the statement:

"Science and technology can help people make moral decisions."
(VOSTS-40221)

some students might **agree** because they reason that science and technology can provide the background information which can help people make moral decisions. Other students might **disagree**, reasoning that, though science and technology can provide background information, the moral decisions must be made by people, not by individuals. In effect, these two groups of students might respond differently to a test item even though they agreed in detail on their point of view.

For such reasons, Aikenhead et. al. have developed an instrument which not only attempts to determine student views on science, technology, and society (VOSTS) but also the various reasons students might have for their choices. In particular, the researchers required students to indicate in writing

their responses to various STS topics. On the basis of these responses, Aikenhead et. al. developed a number of position statements from which students could then select the 'best' reason for their choice. In the present study, we have selected a number of items from the VOSTS inventory and administered these to 56 grade eleven students from a general science, a biology and a physics class, as well as to two grade eight classes of 45 general science students. Previously, VOSTS items had been administered only to high school students with the question of their suitability to younger students still unresolved (Fleming, 1987).

One other point needs some emphasis. Student responses to the VOSTS items are influenced by the context in which the questions are asked. For example, in Fleming (1987, p. 174), students were asked to indicate whether or not scientists should have the main responsibility of deciding which kind of energy Canadians would be using in the future. When the introductory statement indicated that scientists and technologists **should** have that authority, 36% of the students tested agreed on the basis of the scientists' superior training. When the introductory statement suggested that scientists **should not** have that authority, 57% of the students indicated that scientists should have that authority, on the basis of their superior training. This may indicate that even high school students do not have well worked out views on science, technology, and society issues and that the context of the testing situation actually helps them, or influences them, to arrive at a point of view on these issues.

The items we have chosen to report on here fall into the following categories: Science, Technology and their Interaction; Science, Technology and the Quality of Life; and Gender Effects on the Process/Product of Science and Technology.

SCIENCE, TECHNOLOGY, AND THEIR INTERACTION

VOSTS Item 10112 (Table 16)

Defining science is difficult because science is complex and does many things. But MAINLY science is:

The most popular choice among grade eleven students overall (29%) was C, exploring the unknown and discovering new things about the world and universe, and how they work. The next choice (25%) was B, a body of knowledge such as principles, laws and theories which explain the world around us. The only other choice that received more than 10% of the choices (12%) was that science was E, inventing or designing things. This last definition clearly blurs the distinction between science and technology.

Grade eight students evidently saw science as B, a body of knowledge (25% F, 35% m), or as A, a study of fields such as biology, chemistry or physics (35%F, 9% M). A few of the grade eight boys (17%) did suggest that science involved experimentation (Pos. D), and 15% of the girls and 13% of the boys chose position C, exploration of the unknown. On the whole, however, one would judge that the grade eleven students had a more clear recognition that science has both a knowledge and a process component.

When students were asked: What is science? (Student Background Questionnaire, Appendix F, pg.) students had an opportunity to provide their own explanation. The VOSTS items, on the other hand, provide students with specific opinion statements. Students are to select the statement that best describes how they feel about the item. VOSTS provides students with the explanation, whereas the questionnaire allowed students the opportunity to formulate their own definition. Students completed the Student Background Questionnaire prior to the VOSTS statements, thus the VOSTS did not have an opportunity to influence the way students responded.

A common explanation of science at the grade three level was that "science is a thing you do with exeroments", "it's something that you test and see what happens", "science is learning about things". Grade three students

TABLE 16 - 10112

Views on Science - Technology - Society Responses

Defining science is difficult because science is complex and does many things. But MAINLY science is:

Your position, basically:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. a study of fields such as biology, chemistry and physics	8.7	35	21	13	8.0	11
B. a body of knowledge, such as principles, laws and theories, which explain the world around us (matter, energy and life).	35	25	30	23	28	25
C. exploring the unknown and discovering new things about our world and universe and how they work.	13	15	14	29	28	29
D. carrying out experiments to solve problems of interest about the world around us.	17	0.0	9.3	10	8.0	8.9
E. Inventing or designing things (for example, artificial hearts, computers, space vehicles)	4.3	0.0	2.3	0.0	0.0	0.0
F. finding and using knowledge to make this world a better place to live in (for example curing diseases, solving pollution, and improving agriculture).	8.7	5.0	7.0	13	12	13
G. an organisation of people (called scientists) who have ideas and techniques for discovering new knowledge.	0.0	5.0	2.3	3.2	8.0	5.4
H. I don't understand.	8.7	10	9.3	3.2	0.0	1.8
I. I don't know enough about this subject to make a choice.	0.0	0.0	0.0	6.5	4.0	5.4
J. None of these choices fits my basic viewpoint	4.3	0.0	2.3	0.0	4.0	1.8

Note • 1 Grade 8 female did not respond

tend to regard science as a process of carrying out experiments. They see science as an activity, as well as a body of knowledge. They enjoy conducting experiments "to see what happens". This would support item "C" of VOSTS item 10112, (Appendix D) which states that "science is carrying out experiments to solve problems of interest about the world around us".

At the grade eight level male students and female students provided somewhat different responses. Females were concerned with science being related to the environment and the world. One student responded "science is the study of the environment, making decisions, and technology". Another responded "science is the study of the world and how it functions the way it does". On four of the questionnaires completed by the grade eight females they wrote on the top that they hoped that I was going to be "concerned about the environment and recycle the paper I used" to complete this study. One student also suggested that I should have used both sides of the paper in all cases to "help the environment". This shows that they are concerned about the environment, interested in the environment and prepared to question other peoples actions in regard to the environment.

A male student from the science 24 class said that science is " what goes on in nature. eg. weather changes, life, universe, etc."

Biology 20 and Physics 20 males looked at science as being "the study of the world around us" ; science is "exploring, experimenting, gathering information, creating theories to explain the world". When asked to elaborate upon the second response quoted the student replied that "science helps us understand how volcanoes erupt, why earthquakes happen, what happened to dinosaurs, why we have a hole in the ozone layer and how things evolve". Eight students responded in this manner.

Grade eleven females responded in a similar fashion and one of the students provided this definition "science to me is the study of living things like the world and everything that lives in it".

The results from this study show that as grade level increased the student definition of science evolved from our identification of science with specific activities and knowledge related to specific subjects or problems, to

the broader view of science as the explanation of the unknown; as grade level increased the student definition became more sophisticated and more expansive.

VOSTS Item 10211 (Table 17)

Defining what technology is can cause difficulties because technology does many things in Canada. But MAINLY technology is:

The most frequent choices among grade eleven students were that technology involved new processes, instruments, tools, etc. (26%); ideas and techniques for designing and manufacturing things, for organizing workers, business people and consumers, for the progress of society (24%); and the application of science (18%). These were also the most frequently chosen items in Aikenhead (1987). It is interesting to note that only one student chose the alternative that technology is very similar to science. The most popular choice for the grade eight students was that technology is robotics, electronics, computers, etc. Whereas grade eight students thus focussed more on the products of technology, grade eleven students presented a more sophisticated view of technology as a process, not only for inventing specific instruments but as a way of organizing natural and human resources.

Responses to the question, *What is technology?* (Student Background Questionnaire. Appendix F, p. 179) appear to be more similar in nature. Grade three students had difficulty with the word technology and as a result the majority of the students who participated in the study were not able to respond. Those who provided a definition gave the following statements: technology is "computer and other machines nolage", "coputors and electronics", and "building things".

One grade eight male said technology was "taking a science idea and making it useful. (eg. electricity making things run)".

A grade eight female responded by writing that technology is "the inventions that are made by science".

TABLE 17 - 10211

Defining what Technology is, can cause difficulties because technology does many things in Canada.
But MAINLY technology is:

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. very similar to science.	0.0	10	4.7	3.2	0.0	1.8
B. the application of science.	17	5.0	12	26	12	20
C. new processes, instruments, tools, machinery, appliances, gadgets, computers, or practical devices for everyday use.	30	5.0	18	19	36	27
D. robotics, electronics, computers, communication systems, automation, etc..	26	25	26	9.7	8.0	9.0
E. a technique for doing things, or a way of solving practical problems.	4.3	10	7.0	0.0	0.0	0.0
F. inventing, designing and testing things (for example, artificial hearts, computers, space vehicles.)	0.0	0.0	0.0	13	8.0	11
G. ideas and techniques for designing and manufacturing things for organising workers, business people and consumers, for the progress of society.	0.0	20	9.3	23	28	25
H. I don't understand.	13	5.0	9.3	0.0	0.0	0.0
I. I don't know enough about the subject to make a choice.	4.3	10	7.0	6.5	4.0	5.4
J. None of these fits my basic viewpoint.	4.3	10	7.0	0.0	4.0	1.8

A grade eleven female described technology as "the development of tools used to further progress human society".

In support of the interpretation of technology with "tool-making" grade eleven males thought of technology as being the following: "advancements that improve our quality of life", "technology is the application of science devices, etc. that make life easier" and "the mechanical results corresponding to the knowledge of science. eg. science = disease / technology = cure". When asked to elaborate upon this response one particular student reported that we use science to identify and learn more about things, such as diseases, and we come up with technology to help deal with things, such as how to fight cancer. He provided the example of science helping us to find out more about cancer, whereas treating cancer with radiation is a technological remedy to a scientific problem.

It is evident, from the student responses recorded on the background questionnaire, to What is science? and to What is technology? that student definitions at the grade three level are somewhat naive and as grade level increases there is a definite progression to a more sophisticated and mature definition of both science and technology. Students at the grade eleven level were able to distinguish quite clearly between science and technology. This is also evident when one looks at the VOSTS responses.

VOSTS Item 10411 (Table 18)

Science and technology are closely related to each other. They are closely related to each other because:

The clear choice among the grade eleven students (57%) was that science and technology were closely related to each other because scientific ideas lead to technological innovations and technological developments increase the ability to do scientific research. Only 11% of the students chose the hierarchical position that science is the basic activity from which technology is derived (Position A). These results are similar to those reported by Fleming (1987), who found that only 13% of grade twelve students chose the

TABLE 18 - 10411
Science and technology are closely related to each other because:

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. science is the basis of all technological advances; though it's hard to see how technology could aid science.	17	0.0	9.3	6.5	16	11
B. scientific research leads to practical applications in technology and technological developments increase the ability to do scientific research.	26	40	32	55	60	57
C. although they are different, they are linked so closely that it's hard to tell them apart.	8.7	5.0	6.7	6.5	4.0	5.4
D. technology is the basis of all scientific advances; though it's hard to see how science could aid technology	17	0.0	9.3	6.5	16	11
E. Science and technology are basically the same thing.	4.3	25	14	0.0	0.0	0.0
F. I don't understand.	17	15	16	3.2	0.0	1.8
G. I don't know enough about this subject to make a choice.	4.3	10	7.0	6.5	4.0	5.4
H. None of these choices fits my basic viewpoint	4.3	5.0	4.6	16	0.0	8.9

Note • 1 Grade 8 male did not respond

hierarchical position in the same situation. However, Fleming found that 50% of a similar sample of grade twelve students chose the hierarchical alternative when the item was introduced by a statement suggesting that science and technology had little to do with each other. The grade eight students also chose the interaction of science and technology view most often (34%) with the position that science and technology were more or less the same thing, their second choice (14%). Fully 28% of the grade eight students were not able to choose any of the positions. The results suggest that, as children move through the school system, they attain a more mature understanding of the interdependence of science and technology.

SCIENCE, TECHNOLOGY AND THE QUALITY OF LIFE

VOSTS Item 10421 (Table 19)

In order to improve the quality of life in Canada, it would be better to spend money on technological research RATHER THAN scientific research.

Over 78% of the grade eleven students selected a position indicating support for both science and technology, but male and female students indicated different reasons for their choice. For example, 44% of the females and 19% of the males suggested that money should be invested in both areas because each, in its own way, brings certain tangible advantages to society, whereas 12% of the females and 39% of the males suggested both should be supported because science and technology interact and complement each other. Only 7% of the grade eleven students suggested that the money should be invested primarily in technological research, and only 5% of the students favoured investment in scientific rather than in technological research. This differs quite strongly with the result reported by Fleming (1987, p. 170) where 20% of the grade twelve students favoured investment in technological research, and 18% preferred to see money invested in scientific rather than in technological research.

TABLE 19 - 10421

In order to improve the quality of living in Canada, it would be better to spend money and invest in:

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	Male	Female	Total	Male	Female	Total
A. Technological research because it will improve production, economic growth, and unemployment. These are far more important than anything scientific research has to offer.	8.7	0.0	4.7	9.7	4.0	7.1
B. Both because there is really no difference between science and technology.	13	20	16	3.2	0.0	1.8
C. Both because scientific knowledge is needed to make technological advances	39	10	26	19	16	18
D. Both because they interact and complement each other equally. Technology gives as much to science as science gives to technology.	4.3	25	14	39	12	27
E. Both because each, in its own way, brings advantages to society. For example, science brings medical and environmental advances, while technology brings improved conveniences and efficiency.	13	10	12	19	44	30
F. Scientific research - that is, medical or environmental research - because these are more important than making better appliances, computers or other products of technological research.	4.3	10	7.0	6.5	0.0	3.6
G. Scientific research because it improves the quality of life (for example, medical cures, answers to pollution, and increased knowledge). Technology has worsened the quality of life (for example, atomic bombs, pollution, automation, etc.)	0.0	5.0	2.3	0.0	4.0	1.8
H. Neither. The quality of life will not improve with advancements in science and technology, but will improve with investments in other sectors of society (for example, social welfare, education, job creation, the fine arts, foreign aid, etc.)	0.0	0.0	0.0	0.0	12	5.4
I. I don't understand.	8.7	5.0	7.0	0.0	0.0	0.0
J. I don't know enough about this subject to make a choice.	0.0	15	7.0	3.2	4.0	3.6
K. None of these choices fits my basic viewpoint	4.3	0.0	2.3	0.0	4.0	1.8

Note • 1 Grade 8 male did not respond

The majority of the grade eight students also supported investment in both areas, but the most popular justification (33%) was that scientific knowledge is required to make technological advances (Pos. B). It was suggested by Fleming (1987, p. 171) that the 'social benefits' position (including Positions E and F) reflected a blurring of the roles of science and technology creating a new enterprise called technoscience, which especially misrepresents science. However, the only non-technoscience position students could possibly choose was Position B, the interaction-complementary position, chosen by 28% of Fleming's sample and 30% of ours. It would appear, therefore, to be necessary to interview students to ascertain whether or not such blurring is indeed the case. As with the previous question discussed, with increased maturity of the students, came a better understanding of the ways science and technology interact and depend upon each other intimately.

VOSTS Item 20111 (Table 20)

The Canadian government should give scientists research money to explore the curious unknowns of nature and the universe.

The vast majority (90%) of grade eleven students indicated their agreement with the above statement, but by far the most popular reason chosen (43%) was Position D--because by understanding our world better, scientists can make it a better place to live. . . Very few (5.4%) of the students suggested that a sufficient reason for government support was the human urge to know the unknown (Pos. B). In Fleming's sample (p. 178), 54% chose Position D and 23% chose Position B. It is somewhat puzzling that a greater fraction (25% of the girls and 9% of the boys) of the grade eight students chose the 'pure research' justification for support of scientific research. It is also interesting that relatively few (9% of the grade eleven students, 18% of the grade eight students, and 12% of Fleming's sample) justified Canada's support for research because of its competitive position with other nations. The results suggest that student see the main aim of science and technology to be the improvement of the human condition and the environment, rather than the pursuit of pure knowledge.

TABLE 20 - 20111

The Canadian government should scientists research money to explore the curious unknowns of nature and the universe.

Your position, basically:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. Money should be spent on scientific research so Canada does not fall behind other countries and become dependent upon them.	30	5.0	18	6.5	12	8.9
B. Money should be spent on scientific research in order to satisfy the human urge to know the unknown; that is, to satisfy scientific curiosity.	8.7	25	16	6.5	4.0	5.4
C. Money should be spent on scientific research even though it's often impossible to tell ahead of time whether the research will be beneficial or not. It's an investment risk, but we should take it.	8.7	15	12	16	8.0	13
D. Money should be spent on scientific research because by understanding our world better, scientists can make it better place to live in (for example, using nature's environment and resources to our best advantage.)	22	20	21	42	44	43
E. Money should be spent on scientific research only when the research is directly related to our health (especially finding cures for diseases), to our environment or to agriculture.	4.3	10	7.0	16	24	20
F. Little or no money should be spent on scientific research because the money could be spent on other things, such as helping Canada's unemployed and needy, or helping less fortunate countries.	0.0	5.0	2.3	3.2	4.0	3.6
G. I don't understand.	17	5.0	12	3.2	0.0	1.8
H. I don't know enough about this subject to make a choice.	4.3	10	7.0	3.2	4.0	3.6
I. None of these choices fits my basic viewpoint.	0.0	5.0	2.3	3.2	0.0	1.8

VOSTS Item 40411 (Table 21)

Science and technology offer a great deal of help in resolving such social problems as poverty, crime, unemployment, overpopulation and the threat of a nuclear war.

Roughly 53% of the grade eleven students felt that science and technology can help to resolve such problems, 25% because of new scientific ideas or technological inventions (Pos. A); however, 14% felt that science and technology could solve some problems, but not others (Pos. B), and 14% felt that science and technology created as many problems as they solved. Another 25% of the students felt that solving social problems is not so much a question of science and technology but of people using science and technology wisely. In Fleming's study (p. 172), 55% of the students agreed, for one reason or another, that science and technology could help to solve some social problems. None of our grade eleven students chose alternative F, that science and technology only make these problems worse, whereas 17% of Fleming's sample of grade twelve students chose this position. It is clear that students have no overwhelming confidence in the ability of science and technology by themselves to solve all the world's social ills. The necessity for human beings to use their scientific and technological skills wisely is underscored by the next item.

VOSTS item 40451 (Table 22)

We have to be concerned about pollution problems which are unsolvable today. Science and technology can not necessarily fix these problems in the future.

The most popular point of view chosen by 46% of the grade eleven students was Position E, that solving these problems is everybody's responsibility. The only other position chosen by more than 11% of the students was Position D, that no one can predict what science and technology can or cannot solve in the future. Another 19% of the grade eleven **male** students, but

TABLE 21 - 40411
Science and technology offer a great deal of help in resolving such problems as poverty, crime, unemployment, over population, and the threat of nuclear war.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. Science and technology can certainly help to resolve these problems. The problems could use new ideas from science and new inventions from technology.	17	5.0	12	29	20	25
B. Science and technology can help resolve some social problems but not others	0.0	15	7.0	9.7	20	14
C. Science and technology solve many social problems, but science and technology can also <u>cause</u> many of these problems.	0.0	10	4.7	9.7	20	14
D. It's not a question of science and technology helping, but rather it's a question of <u>people</u> using science and technology wisely.	8.7	15	12	32	24	25
E. It's hard to see how science and technology could help very much in resolving social problems. Social problems concern human nature; these problems have little to do it science and technology.	26	20	23	13	8.0	11
F. Science and technology only make social problems worse. It's the price we pay for advances in science and technology.	4.3	5.0	4.7	0.0	0.0	0.0
G. I don't understand.	17	5.0	12	3.2	0.0	1.8
H. I don't know enough about this subject to make a choice.	17	15	16	6.5	8.0	7.1
I. None of these choices fits my basic viewpoint.	4.3	0.0	2.3	3.2	0.0	1.8

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 female did not respond

TABLE 22 - 40451

We have to be concerned about pollution problems which are unsolvable today. Science and technology can not necessarily fix these problems in the future.

Your position, basically:

Science and technology can NOT fix such problems:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. because science and technology are the reason that we have pollution problems in the first place. More science and technology will bring more pollution problems.	8.7	5.0	7.0	6.5	4.0	5.4
B. because pollution problems are so bad today they are already beyond the ability for science and technology to fix them.	17	15	16	3.2	8.0	5.4
C. because pollution problems are becoming so bad that they may soon be beyond the ability of science and technology to fix them.	13	10	12	19	0.0	11
D. No one can predict what science and technology can fix in the future.	17	25	21	16	20	18
E. Science and technology alone cannot fix the pollution problems. It is everyone's responsibility. The public must insist that fixing these problems is a top priority.	0.0	5.0	2.3	35	6.0	46
F. Science and technology can fix these problems because the success at solving problems in the past means science and technology will be successful in the future at fixing pollution problems.	13	5.0	9.3	9.7	4.0	7.1
G. I don't understand.	17	5.0	12	0.0	0.0	0.0
H. I don't know enough about this subject to make a choice.	8.7	10	9.3	6.5	4.0	5.4
I. None of these choices fits my basic viewpoint.	0.0	10	4.7	3.2	0.0	1.8

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 females did not respond

none of the females, indicated that pollution problems may soon be beyond the ability of science and technology to fix. Among the grade eight students the most frequently chosen (21%) position was Position D, that no one can predict what can be solved in the future, with Position B, that pollution problems are already beyond the ability of science and technology to fix, chosen by 16%. As many as 26% of the grade 8 students were unable to indicate their viewpoint on this question. In summary, grade eight and grade eleven science students do not appear to view science and technology as able to solve humanity's problems without the wise application of scientific, technological, and other sources of knowledge.

GENDER EFFECTS ON THE PROCESS/PRODUCT OF SCIENCE AND TECHNOLOGY

VOSTS item 60511 (Table 23)

There are many more women scientists today than there used to be. This will make a difference to the scientific discoveries that will be made. Scientific discoveries made by women will tend to be different than those made by men.

There is no difference between female and male scientists in the discoveries they make:

Fully 79% of the grade 11 students agreed that there would be no difference in the scientific discoveries made by male and female scientists and technologists, with only 3.6% feeling that men would make better scientific discoveries. Thirty-three percent (30%) of the grade eleven students chose as the reason Position A, because any good scientist will eventually make the same discovery as any other scientist, and 20% chose Position G, because any differences in their discoveries would be due to differences between individuals, and not due to gender. Another 13% chose as justification the reason that men and women were equally intelligent (Pos. C) and 13%

TABLE 23 - 60511

There are many more women scientists today than there used to be. This will make a difference to the scientific discoveries which are made. Scientific discoveries made by women will tend to be different than those made by men.

Your position, basically:

There is NO difference between female and male scientists in the discoveries they make:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. because any good scientist will eventually make the same discovery as another good scientist.	17	25	21	32	28	30
B. because female and male scientists experience the same training.	8.7	15	12	3.2	4.0	3.6
C. because overall women and men are equally intelligent.	8.7	15	12	9.7	16	13
D. because women and men are the same in terms of what they discover in science.	0.0	5.0	2.3	0.0	4.0	1.8
E. because research goals are set by demands or desires from others besides scientists.	4.3	0.0	2.3	3.2	8.0	5.4
F. because everyone is equal, no matter what they do.	4.3	10	7.0	6.5	0.0	3.6
G. because any differences in their discoveries are due to differences between individuals. Such differences have nothing to do with being male or female.	8.7	5.0	7.0	19	20	20
H. Women would make somewhat different discoveries because, by nature or by upbringing, females have different values, viewpoints, or characteristics (such as sensitivity toward consequence)	4.3	5.0	4.7	9.7	16	13
I. Men would make somewhat different discoveries because men are better at science than are women	8.7	0.0	4.7	6.5	0.0	3.6
J. women would likely make somewhat better discoveries than men because women are generally better than men at some things such as instinct and memory.	0.0	0.0	0.0	0.0	0.0	0.0
K. I don't understand.	22	10	16	6.5	4.0	5.4
L. I don't know enough about this subject to make a choice.	0.0	0.0	0.0	3.2	0.0	1.8
M. None of these fits my basic viewpoint.	8.7	0.0	4.7	0.0	0.0	0.0

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 females did not respond

suggested that women would make somewhat different discoveries because women tended to have different values, viewpoints, and perspectives (such as sensitivity towards consequences). Only 4% of the grade eleven students felt that men would make somewhat different discoveries because men were better at science than women (Pos. I).

The pattern of responses of these grade eleven students is similar to that of the French and English speaking students in Aikenhead's (1987) sample in which 87% felt there would be no differences in scientific or technological discoveries made by males or females and only 12% felt that there might be some differences. The pattern of justification of their choices was also similar except for one choice. Whereas only 4% of our grade eleven students chose training as the reason why male and female scientists would make similar discoveries (Pos. B), fully 20% of the French speaking students and 6% of the English speaking students chose this reason.

The responses of the grade eight students were also similar with 64% of the students agreeing that men and women would make similar discoveries, and only 9% indicating that they felt that men and women would make different discoveries. Fully 21% of the grade eight students indicated either that they did not understand the question or were unable to make a choice.

VOSTS Item 60531 (Table 24)

**Male scientists concentrate only on the facts which support an idea.
Female scientists in the lab ALSO pay attention to human values.**

There is no difference between female and male scientists:

Fleming (1987, p. 169) suggests that student responses to questions requiring value judgments depend critically upon the introductory statement setting the stage for the question. For example, in a question on the relationship between science and technology, 50% of the students tested chose the hierarchical position that science was fundamental to technology when the introductory statement suggested the independence of science and technology;

TABLE 24 - 60531
Male scientists concentrate only on the facts which support an idea. Female scientists in the lab ALSO pay attention to human values.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
There is NO difference between female and male scientists.						
A. because there is <u>no room</u> for human values in the lab. All good scientists pay attention only to the facts.	0.0	5.0	2.3	9.7	8.0	8.9
B. because it takes <u>intelligence</u> to pay attention to values. Intelligence has nothing to do with being female.	13	15	14	23	24	23
C. because it's a scientist's <u>training</u> which affects whether he or she pays attention to facts more than human values.	4.3	15	9.3	16	0.0	8.9
D. because it's a scientist's <u>individual personality</u> which affects whether he or she pays attention to facts more than to human values.	8.7	5.0	7.0	16	44	29
E. because good scientists pay attention to <u>both</u> the facts and human values when in the lab.	17	5.0	12	9.7	12	11
F. because female and male scientists are <u>the same</u> . Men are as sensitive to human values as women are and women are as logical with facts as men are.	13	10	12	3.2	0.0	1.8
G. because everyone is equal no matter what the job.	8.7	10	9.3	9.7	0.0	5.4
H. Female scientists are more likely to consider human values in research, as well as the facts.	4.3	10	7.0	6.5	4.0	5.4
I. I don't understand.	17	15	16	3.2	4.0	3.6
J. I don't know enough about this subject to make a choice.	4.3	0.0	2.3	3.2	4.0	3.6
K. None of these choices fits my basic viewpoint.	4.3	0.0	2.3	0.0	0.0	0.0

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 females did not respond

only 13% of the students chose that position when the interaction of science and technology was suggested in the introduction. The introduction to the present question gives a mixed message. Ninety percent (90%) of the grade eleven students agreed with the statement that there is no difference between female and male scientists, primarily for two reasons. Thirty percent (29%) chose Position D, that it is a scientist's individual personality which determines the choice of emphasis on facts or on values, and 23% chose Position B, which suggested that the intelligence required to focus on values had nothing to do with being male or female. Only 5% of the students felt that female scientists are more likely to consider values as well as facts. For the grade eight students, the most frequently chosen position was 'I don't understand'. For those grade eight students who did respond with a particular choice, the reasons for agreeing with the statement that there is no difference between female and male scientists were split almost equally among the alternatives. The responses to the above question leave one with the overwhelming impression that science students currently do not believe in a difference in scientific activity between boys and girls and fully believe that male and female scientists have equally important contributions to make in science.

VOSTS Item 60611 (Table 25)

Today in Canada, there are many more male scientists than female scientists. The MAIN reason for this is:

Sixteen percent (16%) of the female students and 35% of the male students in the grade eleven sample suggested that the traditional stereotype that males were more **intelligent** than females (Pos. D) was responsible for the unequal representation of females in the sciences, whereas 40% of the female students and 7% of the male students chose Position F, the traditional stereotype of male female **vocations** as the main reason. About 14% of the grade 11 students felt there were no reasons why there were fewer women in science, that both sexes were equally capable of being scientists, and that opportunities are equal today. Only 7% of the grade 11 students suggested that

TABLE 25 - 60611

Today in Canada, there are many more male scientists than female scientists. The MAIN reason for this is :

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. males are stronger, faster, brighter, and better at concentrating on their studies.	4.3	0.0	2.3	6.5	0.0	3.6
B. males seem to have more scientific abilities than females, who may excel in other fields.	4.3	10	7.0	9.7	0.0	5.4
C. males are just more interested in science than females.	22	35	28	6.5	8.0	7.1
D. the traditional stereotype held by society has been that men are smarter and dominant, while women are weaker and less logical. This prejudice has caused more men to become scientists, even though females are just as capable in science as males.	0.0	0.0	0.0	35	16	27
E. the schools have not done enough to encourage females to take science courses. Females are just as capable in science as males.	8.7	10	9.3	6.5	8.0	7.1
F. Until recently, science was thought to be a man's vocation. In addition, most women were expected to work in the home or take on traditional jobs. Men had more encouragement to become scientists. But this is changing. Science is becoming a vocation for women.	4.3	0.0	2.3	6.5	40	21
G. women have been discouraged, or not allowed, to enter the scientific field. Women are just interested and are just as capable as men; but the established scientists (who are generally male) tend to discourage or intimidate potential female scientists.	4.3	5.0	4.7	6.5	12	8.9
H. There are NO reasons for having more male scientists than female scientists. Both sexes are equally capable of being good scientists, and today opportunities are equal.	17	5.0	12	13	16	14
I. I don't understand.	17	10	14	6.5	0.0	3.6
J. I don't know enough about this subject to make a choice.	8.7	5.0	7.0	3.2	0.0	1.8
K. None of these choices fits my basic viewpoint.	4.3	5.0	4.7	0.0	0.0	0.0

the schools were primarily responsible (Pos. E) for the underrepresentation of females in science by not having done enough to encourage females to enter science. The pattern of responses of the grade eight students was somewhat different in that about 30% of the students making a choice chose Position C, that males are just more interested in science than females, as the main reason why there are fewer women in scientific careers today.

All in all, it is clear that the vast majority of the students tested, whether in grade eleven or in grade eight, feel that there are no good reasons why there should not be an equal number of female scientists and male scientists. Moreover, the students feel that there will be no fundamental differences between the type of science done by male and female scientists. The students also feel that the current underrepresentation of females in scientific and technological careers is due to a number of different social stereotypes that have no basis in reality.

SUMMARY

In the first two items posed, grade eleven students appeared to be able to distinguish quite clearly between science and technology. In the definition of both science and technology, the most popular positions involved the fairly sophisticated ones of the processes of discovery or of invention, and the products of science and technology, the body of knowledge or body of new inventions. Students clearly understood the interactive nature and mutual interdependence of science and technology, with very few students choosing the hierarchical position of science being fundamental to technology, and also very few students considering science and technology to be essentially the same thing.

In terms of the public support of science and technology, students felt that both should be supported, but mostly because of the tangible advantages each can give to society. Very few suggested that science should be publicly supported simply to satisfy the human urge to explore the unknown. Only a

slight majority of grade eleven students felt that Canadian students should take more science courses of any type. One could conclude, in fact, that fewer than 50% of the grade eleven students felt that they should take more of the presently offered type of science courses. A large fraction of students felt that science and technology could help in solving the problems of pollution, but that the main responsibility rested on the shoulders of all citizens.

The vast majority of grade eleven and grade eight students surveyed felt that there were, and should not be, barriers to females wanting to enter a career in science and technology. Fewer than 5%, both of the grade eleven and of the grade eight students, felt that men were intrinsically better at doing science. Students selected a number of different stereotypes responsible for the current underrepresentation of women in science.

Since the responses of the grade eight students to the positions 'I don't know', 'I don't understand' or "doesn't fit my basic viewpoint", plus no answer at all, varied from just below 20% to well over 50%, it is clear that many of the VOSTS items are too difficult for grade 8 students and a different type of questionnaire would be required to ascertain junior high school students' views on STS issues.

CHAPTER VI

SUMMARY, IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

SUMMARY

The purpose of this study was to examine student attitudes toward science and technology and toward science and technology based careers. Answers were sought to the following questions: 1. *What attitudes are held by grade three, grade eight and grade eleven students toward the areas of science and technology?* and 2. *What attitudes are held by grade three, grade eight and grade eleven students toward scientific and technological careers?*

One hundred and thirty six students from the Edmonton Public School Board provided research information. Thirty-three elementary students, forty-four junior high students and fifty eight high school students participated in the study. The diminutive sample size is a limitation of this research and consequently care should be taken in generalizing the findings of this research.

Instruments used in the study were the Yager and Penick *Preferences and Understandings* Instrument, the Simpson and Troost *Attitude Questionnaire*, Aikenhead's *Views on Science-Technology-Society* statements and a researcher-constructed Student Background questionnaire. These instruments were used to obtain indications of student attitudes toward science and technology and toward scientific and technological careers. As well, three students from each grade level took part in an interview that was conducted by the researcher. It was thought that if one questioned a student who liked science, a student who did not like science and a student who neither liked nor disliked science one might discover the reasons behind the responses on paper and pencil information collection devices.

Historically there has been confusion over defining what attitude is,

and over establishing the differences between scientific attitude and attitude toward science. This led to a lack of conceptual clarity. Attitude studies completed in the eighties appear to have established a theoretical foundation. This has assisted in the development of instruments that provide readily interpretable and comparable results. Instruments, like those used in this study, are beginning to be utilized as attitudinal assessment devices by more and more researchers. Instruments are being refined and their quality improved, which ultimately improves the reliability of subsequent research results.

It has been recognized that the development of cognitive abilities in science is not enough and it is evident that this has been recognized by educational policy makers for they have identified that the current and future aims of science education must include student attitude development. Gardner (1975) agrees that educating for the acquisition of cognitive attributes alone is not adequate. Educators must recognize that affective attitudes are as important as cognitive attitudes in influencing student learning outcomes, career choices and uses of their leisure time. Favourable attitudes are valuable to promote learning and could attract young people into scientific and technological careers. The acquisition of positive student attitudes should be a priority for educators and policy makers. Positive student attitudes undoubtedly increase interest, increase understanding, and increase student commitment to science. An objective of science education should be to better prepare students for their many roles as citizens in a scientifically and technologically literate age.

If science teachers are to teach towards the student acquisition of positive attitudes towards science and positive attitudes regarding the pursuit of scientific literacy then teachers should expect that they will in some way determine the achievement of those objectives. Determining student attitudes is a practical endeavour. By determining student attitudes toward science science teachers may become more aware of the affective development of their students and, as a result, they may better understand and better meet the needs of their students. Many teachers believe in the ideal that schools

should help students develop their potential, meeting the cognitive and affective needs of their students will help teachers realize this objective.

Science teachers want their students to enjoy the things they do in science and they want their enjoyment to make them want to do more and think more both in science class and out of science class. Teachers want to encourage interest in science and the ultimate goal of science education should be to "stimulate joy, wonder, satisfaction and delight in children as a result of their encounters with science". (Gardner, 1975, pg. 1)

Our science students need to acquire positive attitudes toward science and they need to believe in the value of science and of technology. Data from this study does identify that the participating students from all grade levels do value science and do value technology.

Students must be aware of the importance of science and technology and the effect that they have on our daily lives. Science is very much a part of the common culture, integrally tied to public policy and political affairs. Science and technology are increasingly defining our lives and as a result scientific literacy is becoming a necessary skill. Scientific literacy is particularly important for our nation and the world are impacted by the results of scientific and technological activity.

A BRIEF SUMMARY OF THE FINDINGS

Contrary to the findings of Yager and Penick, and Simpson and Troost attitudes toward science do not appear to decline as students study more and more science. In particular, science student found science classes to be fun and interesting and felt that their science experiences made them feel curious about the natural world, at all the levels tested.

With regard to their perception of science teachers, the Edmonton students tested felt that their science teachers encouraged student ideas to a much greater extent than the Yager and Penick sample. Students also felt that the Edmonton teachers were much more willing to admit that they did not know everything about a topic than the Yager and Penick study found.

On the whole, students had a fairly realistic view of science as a career. Students at all levels suggested that being a scientist would be fun, but would also involve a lot of hard work to achieve. On the Simpson and Troost questionnaire, however, the majority of students indicated that they did not see themselves pursuing a scientific career, although they had a high opinion of people who were scientists.

The correlations between the subscales of the Yager and Penick And Simpson and Troost attitude tests were very similar to those in the American study. This study found that for all grade levels there was a positive correlation between attitude toward science and the value of science, and between attitude toward science and attitude toward science teacher. All three grade levels show an understandably negative correlation between science anxiety and attitude toward science, and science anxiety and student achievement/motivation.

In the Views on Science-Technology-Society (VOSTS) questionnaire, most students saw science either as a process of exploration of the unknown, or as a product- a body of knowledge, with the application of science towards making the world a better place to live, a distant third choice.

Brouwer (1992) gives four prevalent definitions of technology:

1. Technology is identified with the development of new products.
2. Technology is identified with new tools and techniques.
3. Technology is the organization of all knowledge for practical purposes.
4. Technology is a way of looking at nature as a human resource.

Whereas grade eight students tended to focus primarily on the first definition - that technology is associated with new products, the grade eleven students focused primarily on the second and third definition, exhibiting a

more mature understanding of technology. Both grade eight and grade eleven students clearly distinguished between science and technology, through recognizing their interdependence.

As in the Aikenhead (1987) study, fewer than 5% of the students expected any gender differences in the ability to do science. The vast majority of the students felt that girls and boys are equally good candidates for scientific careers.

From student responses gleaned from the Student Background questionnaire it is evident that students desire more relevancy in their science programs. They want "science", "technology", "practical information that can be useful to everyone", and "things that we will definitely need for the future". They are interested in "science fundamentals" and they want to know "how it relates to the world". Students want science teachers to relate science "to life", or "to everyday things".

Students want teachers who are dynamic and who are not bound to textbooks. They want teachers who have a sense of humour. They expect science classes to interest them and want teachers to present appropriate and relevant materials. One student commented that the material presented in science class should "challenge" the thinking of the students. Teachers can achieve this objective by combining science education with the lives of their students. Teachers must provide activities which are meaningful and realistic. They must present their material as one student put it with "oomph and excitement. The student background questionnaire identifies that hands on activities such as dissections, chemistry experiments and especially labs are popular among students of all ages. Students also identified that they would enjoy "going on interesting field trips" and "watching videos".

Student responses also indicated that our young people are interested in pursuing environmental education and they are concerned about what happens to our environment. An example to support this is the fact that four grade eight students inquired both verbally and in written form on the questionnaire booklet as to whether or not I was going to recycle the paper instruments used to conduct this study. I assured them that any paper that

was to be discarded would definitely be recycled.

Some of the results from this study are similar to those found by the Canadian Second International Science Study (SISS). The British Columbia results show that their grade four students think science is an important subject and Ontario students are in agreement that science is important to the individual and to society. This correlates positively with the findings from this study, for all Edmonton students surveyed value science.

Ontario students tended to hold positive attitudes toward doing experiments. Edmonton students would agree with their Ontario peers for they too enjoy conducting scientific experiments and state that that is one of the reasons why they like science.

The Canadian Second International Science Study also found that boys have more favourable attitudes to science than girls. This study found somewhat different results. The grade three and grade eleven female students in this study appear to hold very positive attitudes towards science, in many instances, as favourable or more favourable than males.

The results of this study concur most with that of Barrington and Hendricks (1988). Both this study and their study found that there were no really significant gender effect and that grade three and grade eleven students possess more favourable attitudes than grade eight students.

Students value technology because they believe it provides us with new tools, appliances and gadgets; practical devices for daily use. As Galileo would suggest tools that "lessen the toil of mankind". The VOSTS statements (10311) identify that students believe that science and technology allows research and development to benefit society.

High school students believe (VOSTS -20511 and 20521) that students should study science in school so they they will become more informed and can thus form better opinions.

The sub questions I posed in Chapter One have partially been answered. Why don't our students want to "challenge" themselves? It appears as if they would prefer to pursue areas of study and careers that do not require as much work as scientific and technological professions. How

can educators nurture more favourable student attitudes toward science and technology? Educators can nurture more favourable attitudes toward science by providing a learning environment that is positive and that keeps student anxiety to a minimum. Teachers should as well provide relevant and practical curriculum, with as many hands-on opportunities as is feasible. How can teachers make students less apprehensive about pursuing professions that require lengthy and demanding post-secondary education? I believe that we can interest them in these professions by exposing them to dynamic role-models or mentors. Grade eleven students indicated, on the Student Background Questionnaire, that they were interested in being exposed to scientific and technological role-models. Some professions identified were that of Marine Biologist, Zoologist, Engineer, Nurse, Ecologist, Computer Analyst and Nuclear Physicist. By exposing our youth to dynamic, "real-life" experts they might become more willing and more interested to make a commitment to science. Programs such as WISEST, SHAD Valley, or the Science and Technology segment of the Encounters with Canada program can provide students with excellent role-models and incredible opportunities. Teachers can also invite guest speakers in or take their students out on field trip that allows them to interact with scientific and technological professionals.

SUGGESTIONS FOR FURTHER RESEARCH:

Different questions arose during the course of this study. Some of the questions come to mind because as I analyzed the results I became aware of significant differences that existed between Canadian and American students. When one considers that the media often compares American educational situations and American students directly to Canadian educational situations and Canadian students, the results of this study become even more intriguing. Maybe our Canadian students are in actuality not so similar to their American counterparts. Maybe we should be conducting more of our own research to identify findings that truly describe what is happening here in Canada. The research questions I have considered follow. Research conducted in the

following areas would be necessary in order to answer them.

1. What attitudes are held by grade three, grade eight and grade eleven students toward the areas of science and technology in the City of Edmonton? In the Province of Alberta? Similar research to the present could be conducted with a larger population of students, a city-wide or province-wide study. I would recommend province-wide. This study surveyed students from three Edmonton Public schools and it would be interesting to see if the findings are similar with a larger sample. Other students might have different perceptions related to their science class exposure.
2. How do student attitudes toward science change over time? A group of students from across the province and from a variety of school settings could participate in a longitudinal study. They could be part of a longitudinal study that would assess the development of student attitudes over time. The time span could be from grade three to grade twelve.
3. How does student self-concept influence student success in the science classroom?.
4. What conditions influence student attitudes toward science?
5. How can one decrease student anxiety in the science classroom?
6. How do elementary teachers, compared to high school teachers, make studying science more exciting?
7. In a wider study one might want to investigate what differences do teachers have on student attitudes toward science and technology?

IN CONCLUSION

The instruments used in this study have obtained a measurement of affective variables. They have measured student attitudes toward science and technology. One could extend the procedures outlined in this study to encompass a more inclusive range of affective variables to measure scientific attitudes.

This researcher believes that attitude research is valuable. Gardner tells us that we need the professional expertise to move the results of attitude research into the schools. (pg. 33) By moving the results into schools classroom teachers could benefit. Improved communication and increased conceptual clarity could decrease or eliminate the ambiguity that has historically nagged attitude research. Attention could be paid to studying the effects of particular teaching strategies. Teacher characteristics and the interaction between these and pupil characteristics on the development of scientific attitudes. If I were to conduct this study again I would combine the Simpson and Troost assessment devices. I feel that the different items that each document possessed could in fact compliment each other. I would also conduct more student interview so that I could acquire the "stories" behind the responses. Students do not appear to be afraid to share what they think with you and they provide a wealth of information. I believe a skilled interviewer who could mask facial and body language, who could be a good listener and who could ask thoughtful, clear, prepared questions could identify many of the attitude issues or concerns that exist within the classroom.

In retrospect I would not have had the students complete so many instruments. The reason why I utilized the number of data collection devices that I did was in hope that the findings from the various instruments would be similar to each other, thus they would be able to validate each other. The instruments did demonstrate agreement with each other which was definitely of value.

The students who participated in this study did not appreciate having to

complete all of the forms. Students complained about the amount of reading and writing that was expected of them. They complained about how long it took them, with the grade eight students complaining the loudest. The form they had the greatest amount of difficulty with was that of the VOSTS statement. This document does require that students read a great deal and that they concentrate on their reading. Each VOSTS item is in fact lengthy and students complained about the time and effort required. Some of this complaining could have possibly been avoided if I had selected to spread out the administration of the instruments. This approach might have proved more advantageous and might have even provided more positive student responses as they would have been less fatigued when completing each instrument.

The desire to investigate student attitudes has been somewhat of a labour of love for as a science teacher it is important for me to not only teach students the cognitive curriculum but it is also important to teach them to be curious and interested in our scientific and technological world. This researcher agrees with Sears and Kessen (1964) who state that "the first task and central purpose of science education is to awaken within the child, whether or not he will become a professional scientist, a sense of the joy, a sense of the excitement and a sense of the intellectual power of science."

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APPENDICES

APPENDIX A

PREFERENCES AND UNDERSTANDINGS

STUDENT VERSION

(Revised October, 1987)

Yager and Penick

Name: _____

Male: _____

Female: _____

Grade 3: _____ Grade 8: _____ Grade 11: _____

Name of the science course for which you are presently enrolled in: _____

DIRECTIONS:

The purpose of these questions is to get your reactions to your experiences with science. **There are no right or wrong answers.** However, your reactions and that of your classmates can help your teachers and others to plan new programs more appropriate for you.

Circle the letter that best answers the question for you. Please answer each of the following items as honestly as possible.

PREFERENCES AND UNDERSTANDINGS**Yager and Penick****1. What is your favorite subject in school?**

- A. language arts
- B. social studies
- C. mathematics
- D. science
- E. art
- F. physical education
- G. music
- H. foreign languages

2. What is your next (second) favorite subject?

- A. language arts
- B. social studies
- C. mathematics
- D. science
- E. art
- F. physical education
- G. music
- H. foreign languages

3. What is your least favorite subject in school?

- A. language arts
- B. social studies
- C. mathematics
- D. science
- E. art
- F. physical education
- G. music
- H. foreign languages

4. **Do you wish you had more time for science classes in school?**
A. yes
B. no
C. I don't know
5. **Do you wish you had more kinds of science courses to take?**
A. yes
B. no
C. I don't know
6. **What "kind" of science do you like best?**
A. science that is about living things
B. science that emphasizes the physical world
C. science that stresses the earth and the universe
7. **Does your science teacher ask you many questions about science?**
A. yes
B. no
C. I don't know
8. **Does your science teacher like for you to ask questions about science?**
A. yes
B. no
C. I don't know
9. **Does your science teacher encourage you to give your own answers?**
A. yes
B. no
C. I don't know
10. **Does your science teacher really like science him/herself?**
A. yes
B. no
C. I don't know

11. **Does your teacher make studying science exciting?**
A. yes
B. no
C. I don't know
12. **Does your teacher know much science?**
A. yes
B. no
C. I don't know
13. **Does your science teacher admit to not knowing answers to your questions?**
A. yes
B. no
C. I don't know
14. **Does your science class make you feel prepared to make decisions?**
A. yes
B. no
C. I don't know
15. **Is your science class fun?**
A. yes
B. no
C. I don't know
16. **Is your science class interesting?**
A. yes
B. no
C. I don't know
17. **Is your science class exciting?**
A. yes
B. no
C. I don't know

18. **Is your science class boring?**
A. yes
B. no
C. I don't know
19. **Does your science class make you feel uncomfortable?**
A. yes
B. no
C. I don't know
20. **Does your science class make you feel successful?**
A. yes
B. no
C. I don't know
21. **Does your science class make you feel curious?**
A. yes
B. no
C. I don't know
22. **Are the things you learn in science useful to you when you are not in school?**
A. yes
B. no
C. I don't know
23. **Do you think that knowing science will help you in the future?**
A. yes
B. no
C. I don't know
24. **Do you feel that the science you study is generally useful to you?**
A. yes
B. no
C. I don't know

25. Do you feel that your study of science is useful in helping you to make choices?
- A. yes
 - B. no
 - C. I don't know
26. Do you think that being a scientist would be fun?
- A. yes
 - B. no
 - C. I don't know
27. Do you think that being a scientist would make you rich?
- A. yes
 - B. no
 - C. I don't know
28. Do you think that being a scientist would be a lot of work?
- A. yes
 - B. no
 - C. I don't know
29. Do you think that being a scientist would be boring for you?
- A. yes
 - B. no
 - C. I don't know
30. Do you think that being a scientist would make you feel important?
- A. yes
 - B. no
 - C. I don't know
31. Do you think that being a scientist would make you lonely?
- A. yes
 - B. no
 - C. I don't know

32. **Is science class boring for you?**
A. yes
B. no
C. I don't know
33. **Do you use what you learn in science class outside of school?**
A. yes
B. no
C. I don't know
34. **Do you talk about science careers in science class?**
A. yes
B. no
C. I don't know
35. **Do you have fun trying to solve problems included in your science class?**
A. yes
B. no
C. I don't know
36. **Do your parents ask you questions about what you do in science class?**
A. yes
B. no
C. I don't know
37. **Does technology effect your daily living?**
A. yes
B. no
C. I don't know
38. **Do you use information you learn in science in situations outside of school?**
A. yes
B. no
C. I don't know

39. **What do you think is the most important part of science?**
- A. knowing about your world
 - B. thinking through problems
 - C. being curious and exploring
 - D. explaining things you see
 - E. testing your ideas
40. **Do you think it is important to plan experiments to test your own ideas to see if they are right or wrong?**
- A. yes
 - B. no
 - C. I don't know

APPENDIX B

STUDENT QUESTIONNAIRE XIII
(SIMPSON AND TROOST)

Name: _____

Male: _____ Female: _____

Grade 3: _____ Grade 8: _____ Grade 11: _____

Name of the science course for which you are presently enrolled in: _____

This survey consists of a number of statements designed to sample your opinions about science. **There are no right or wrong answers.** What is wanted is your own individual feelings about the statements. Please read each statement carefully and decide how **you** feel about it.

Directions:

Please mark the response which best represents your opinion to the following statements directly on the questionnaire.

1. **I would enjoy being a scientist.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

2. **My friends like science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

3. **I like our science textbook.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

4. **We learn about important things in science class.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

5. **Our science classroom contains a lot of interesting equipment.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

6. **We cover interesting topics in science class.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

7. **I enjoy science courses.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

8. **Science makes me feel as though I'm lost in a jungle of numbers and words.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

9. **I would probably not do well in science if I took it in college or University.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

10. **I like to make decisions for myself.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

11. **I always try to do my best in school.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

12. **Science is fun.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

13. **We do a lot of fun activities in science class.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

14. **The students work together well in this class.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

15. **My parents help me with my science homework.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
16. **My science teacher encourages me to learn more science.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
17. **I consider myself a good science student.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
18. **My mind goes blank when I am doing science.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
19. **I feel like I have little control over what happens to me at school.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
20. **I consider my science classroom attractive and comfortable.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
21. **My science teacher makes good plans for us.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
22. **I try hard to do well in science.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
23. **I have good feelings toward science.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
24. **I feel I have a number of good qualities.**
Strongly Agree Agree Undecided Disagree Strongly Disagree
25. **I feel nervous in science class.**
Strongly Agree Agree Undecided Disagree Strongly Disagree

26. **My parents expect me to do well in school.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

27. **I think scientists are neat people.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

28. **Luck seems to be more important in life than hard work.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

29. **My science teacher expects me to make good grades.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

30. **The harder I try, the better I do in school.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

31. **My family watches science programs on TV.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

32. **I enjoy talking to my science teacher after class.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

33. **My mother likes science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

34. **I think I am capable of becoming an engineer, scientist or doctor.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

35. **Everyone should learn about science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

36. **My father likes science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

37. **Science tests make me nervous.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

38. **I usually look forward to my science class.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

39. **My best friend in this class likes science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

40. **Sometimes my science teacher makes me feel dumb.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

41. **I really like science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

42. **My brothers and sisters like science.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

43. **I always try hard, no matter how difficult the work.**

Strongly Agree Agree Undecided Disagree Strongly Disagree

44. **I live with**

- A. both parents
- B. my mother
- C. my father
- D. grandparents
- E. others

45. **I am**

- A. right handed
- B. left handed
- C. use both hands equally well

APPENDIX C

VIEWS ON SCIENCE-TECHNOLOGY-SOCIETY
Form CDN.mc.5**INSTRUCTIONS TO STUDENTS:**

Each question of the VOSTS inventory begins with a statement about a science-technology-society topic. Most of these statements express an extreme view on the topic. You may happen to agree strongly with this view; you may happen to disagree vigorously; or your own position may be in between the two.

Next, there is a list of positions (or viewpoints) on the issue. These usually go from one extreme to the other. You are asked to choose one of these positions, **BUT ONLY ONE** -- the one that comes closest to your personal view or belief.

- To summarize:
- Read the statement carefully.
 - Think to yourself whether you agree or disagree with the statement, or can't make up your mind.
 - Then read the list of different positions on the topic.
 - Pick the one that comes closest to your own position.

Every page ends with the same three positions. Here is how you can use them if you wish:

- X. "I don't understand." This choice is included in case there is a key word or phrase that you just don't understand.
- Y. "I don't know enough about this subject to make a choice.
- Z. "None of these choices fit my basic viewpoint." This choice can be used when none of the other positions comes close to your own belief, or when you want to combine two or more choices into one position.

There are no "right" answers; this is not a test. We simply want to understand what your position is on a number of issues about science and about how it relates to technology and society.

PLEASE DO NOT MAKE ANY MARKS IN THE QUESTION BOOKLET.

**10112 Defining science is difficult because science is complex
and does many things. But MAINLY science is:**

Your position, basically: (Please read from A to J, then choose one.)

- A. a study of fields such as biology, chemistry and physics.
- B. a body of knowledge, such as principles, laws and theories, which explain the world around us (matter, energy and life).
- C. exploring the unknown and discovering new things about our world and universe and how they work.
- D. carrying out experiments to solve problems of interest about the world around us.
- E. inventing or designing things (for example, artificial hearts, computers, space vehicles).
- F. finding and using knowledge to make this world a better place to live in (for example, curing diseases, solving pollution and improving agriculture).
- G. an organization of people (called scientists) who have ideas and techniques for discovering new knowledge.
- H. I don't understand.
- I. I don't know enough about this subject to make a choice.
- J. None of these choices fits my basic viewpoint.

**10211 Defining what technology is, can cause difficulties
because technology does many things in Canada. But
MAINLY technology is:**

Your position, basically: (Please read from A to J, then choose one.)

- A. very similar to science.
- B. the application of science.
- C. new processes, instruments, tools, machinery, appliances, gadgets, computers, or practical devices for everyday use.
- D. robotics, electronics, computers, communication systems, automations, etc.
- E. a technique for doing things, or a way of solving practical problems.
- F. inventing, designing and testing things (for example, artificial hearts, computers, space vehicles).
- G. ideas and techniques for designing and manufacturing things for organizing workers, business people and consumers, for the progress of society.
- H. I don't understand.
- I. I don't know enough about this subject to make a choice.
- J. None of these choices fits my basic viewpoint.

- 10311 Science and technology are important to the research and development (R & D) in Canadian industry. What does "research and development" mean to you?**

Your position, basically: (Please read from A to K, and then choose one.)

- A. R & D means finding new answers to questions about the world and about people.
- B. R & D means progress by making life easier and the quality of life better.
- C. Research is exploring for new facts, ideas and information. Development is putting them to use in order to benefit society.
- D. Research is exploring for new facts, ideas and information. Development is putting them to use by coming up with new and creative ideas.
- E. R & D means exploring new ideas and problems in industry, in order to help an industry overcome its problems and thereby produce newer and better products.
- F. R & D means a combination of science and technology. Research leads to development, and development leads to improved research.
- G. R & D usually means helping humanity by finding medical cures and new technologies. But unanticipated effects of R & D can also cause social problems.
- H. R & D usually means helping humanity by finding medical cures and new technologies. But R & D also means harming society by creating such things as nuclear arms and other wasteful technologies. It depends on the R & D or how it is used.
- I. I don't understand.
- J. I don't know enough about this subject to make a choice.
- K. None of these choices fits my basic viewpoint.

- 10411 Science and technology are closely related to each other.**

Your position, basically: (Please read from A to H, and then choose one.)

They are closely related to each other:

- A. because science is the basis of all technological advances; though it's hard to see how technology could aid science.
- B. because scientific research leads to practical applications in technology, and technological developments increase the ability to do scientific research.
- C. because although they are different, they are linked so closely that it's hard to tell them apart.
- D. because technology is the basis of all scientific advances; though it's hard to see how science could aid technology.
- E. Science and technology are more or less the same thing.
- F. I don't understand.
- G. I don't know enough about this subject to make a choice.
- H. None of these choices fits my basic viewpoint.

10421 In order to improve the quality of living in Canada, it would be better to spend money on technological research RATHER THAN scientific research.

Your position, basically: (Please read from A to K, and then choose one.)

- A. Invest in technological research because it will improve production, economic growth, and unemployment. These are far more important than anything that scientific research has to offer.

Invest in both:

- B. because there is really no difference between science and technology.
C. because scientific knowledge is needed to make technological advances.
D. because they interact and complement each other equally. Technology gives as much to science as science gives to technology.
E. because each in its own way brings advantages to society. For example, science brings medical and environmental advances, while technology brings improved conveniences and efficiency.

F. Invest in scientific research--that is, medical or environmental research--because these are more important than making better appliances, computers or other products of technological research.
G. Invest in scientific research because it improves the quality of life (for example, medical cures, answers to pollution, and increased knowledge). Technological research, on the other hand, has worsened the quality of life (for example, atomic bombs, pollution, automation, etc.).
H. Invest in neither. The quality of living will not improve with advances in science and technology, but will improve with investments in other sectors of society (for example, social welfare, education, job creation programs, the fine arts, foreign aid, etc.).

I. I don't understand.
J. I don't know enough about this subject to make a choice.
K. None of these choices fits my basic viewpoint.

- 10431 Technologists have their own body of knowledge to build on. Few developments in technology have come directly from discoveries made in science.**

Your position, basically: (Please read from A to H, and then choose one.)

- A. Technology advances mainly on its own. It doesn't necessarily need scientific discoveries.
- B. Technology advances by relying equally on both scientific discoveries and technology's own body of knowledge.
- C. Both scientists and technologists depend on the same body of knowledge, because science and technology are so similar.

EVERY technological development builds on a scientific discovery:

- D. because scientific discoveries always find a use, whether for technological developments or for other scientific uses.
- E. because science provides the background information and the new ideas for technology.
- F. I don't understand.
- G. I don't know enough about this subject to make a choice.
- H. None of these choices fits my basic viewpoint.

- 20111 The Canadian government should give scientists research money to explore the curious unknowns of nature and the universe.**

Your position, basically: (Please read from A to I, and then choose one.)

Money should be spent on scientific research:

- A. so Canada does not fall behind other countries and become dependent upon them.
- B. in order to satisfy the human urge to know the unknown; that is, to satisfy scientific curiosity.
- C. even though it's often impossible to tell ahead of time whether the research will be beneficial or not. It's an investment risk, but we should take it.
- D. because by understanding our world better, scientists can make it a better place to live in (for example, using nature's environment and resources to our best advantage, and by inventing helpful technology).
- E. only when the research is directly related to our health (especially finding cures for diseases), to our environment or to agriculture.
- F. Little or no money should be spent on scientific research because the money could be spent on other things, such as helping Canada's unemployed and needy, or helping less fortunate countries.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

- 20511 The success of science and technology in Canada depends on us having good scientists, engineers and technicians. Therefore, Canada should require students to study more science in school.**

Your position, basically: (Please read from A to K, and then choose one.)

Students should be required to study more science:

- A. because it is important for helping Canada to keep up with other countries.
- B. because science affects almost every aspect of society. As in the past our future depends on good scientists and technologists.
- C. Students should be required to study more science, but a different kind of science course. Students should learn how science and technology affect their everyday lives.

Students should NOT be required to study more science:

- D. because other school subjects are equally or more important to Canada's successful future.
- E. because it won't work. Some people don't like science. If you force them to study it, it will be a waste of time and will turn people away from science.
- F. because not all students can understand science, even though it would help them in their life.
- G. because not all students can understand science. Science is not really necessary for everyone.
- H. because it's not right for someone else to decide if a student should take more science.
- I. I don't understand.
- J. I don't know enough about this subject to make a choice.
- K. None of these choices fits my basic viewpoint.

- 20521 The success of science and technology in Canada depends on how much support the public gives to scientists, engineers and technicians. This support depends on high school students--the future public--learning how science and technology are used in Canada.

Your position, basically: (Please read from A to H, and then choose one.)

Yes, the more students learn about science and technology:

- A. the better they will keep the country running. High school students are the future.
- B. the more students will become scientists, engineers and technicians, and so Canada will prosper.
- C. the more informed the future public will be. They will be able to form better opinions and make better contributions to how science and technology are used.
- D. the more the public will see that science and technology are important. The public will better understand the views of experts and will provide the needed support for science and technology.
- E. No, support does not depend on students learning more about science and technology. Some high school students are not interested in science subjects.
- F. I don't understand.
- G. I don't know enough about this subject to make a choice.
- H. None of these choices fits my basic viewpoint.

40221 Science and technology can help people make some moral decisions (that is, one group of people deciding how to act towards another group of people.)

Your position, basically: (Please read from A to I, and then choose one.)

Science and technology can help you make some moral decisions:

- A. by making you more informed about people and the world around you. This background information can help you cope with the moral aspects of life.
- B. by providing background information; but moral decisions must be made by individuals.
- C. because science includes areas like psychology which study the human mind and emotions.

Science and technology cannot help you make a moral decision:

- D. because science and technology have nothing to do with moral decisions. Science and technology only discover, explain and invent things. What people do with the results is not the scientist's concern.
- E. because moral decisions are made solely on the basis of an individual's values and beliefs.
- F. because if moral decisions are based on scientific information, the decisions often lead to racism, by assuming that one group of people is better than another group.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

40231 Science and technology can NOT help people make legal decisions; for example, deciding if a person is guilty or not guilty in a court of law.

Your position, basically: (Please read from A to G, and then choose one.)

Science and technology can NOT help:

- A. because they have nothing to do with legal decisions, since legal decisions are based on moral values and beliefs.
- B. because it's wrong to base legal decisions on technology such as the lie detector.

Science and technology CAN help in a number of cases:

- C. by developing ways to gather evidence and by testifying about the physical facts of a case.
- D. by studying human behaviour and explaining the human circumstances of a case.
- E. I don't understand.
- F. I don't know enough about this subject to make a choice.
- G. None of these choices fits my basic viewpoint.

40311 We always have to make trade-offs (compromises) between the positive and negative effects of science and technology.

Your position, basically: (Please read from A to K, and then choose one.)

There are always trade-offs between benefits and negative effects:

- A. because every new development has at least one negative result. If we didn't put up with the negative results, we would not progress to enjoy the benefits.
- B. because scientists cannot predict the long-term effects of new developments, in spite of careful planning and testing. We have to take the chance.
- C. because things that benefit some people will be negative for someone else. This depends on a person's viewpoint.
- D. because you can't get positive results without first trying a new idea and then working out its negative effects.
- E. but the trade-offs make no sense. (For example: Why invent labour saving devices which cause more unemployment? or Why defend a country with nuclear weapons which threaten life on earth?)

There are NOT always trade-offs between benefits and negative effects:

- A. because some new developments benefit us without producing negative effects.
- B. because negative effects can be minimized through careful planning and testing.
- C. because negative effects can be eliminated through careful planning and testing. Otherwise, a new development is not used.
- I. I don't understand.
- J. I don't know enough about this subject to make a choice.
- K. None of these choices fits my basic viewpoint.

- 40321** **More money should be spent on science and technology in Canada even though this money will not be available for other things, such as social programs, education, business incentives and lower taxes.**

Your position, basically: (Please read from A to H, and then choose one.)

MORE money should be spent on science and technology:

- A. so Canada can be competitive with the rest of the world.
- B. so Canadians' daily lives can be improved; for example, by making things easier to do, creating new industries and jobs, helping the economy, and solving health problems.
- C. but only if the money is spent on such things as curing diseases, working on pollution, or improving the food supply for the starving.
- D. The money should be spent in a balanced way as it is today. Science and technology are very important but they are not the only things that need money for progress in Canada.
- E. LESS money should be spent on science and technology so more money is available for such things as social programs, education, business incentives and lower taxes.
- F. I don't understand.
- G. I don't know enough about this subject to make a choice.
- H. None of these choices fits my basic viewpoint.

- 40411** **Science and technology offer a great deal of help in resolving such social problems as poverty, crime, unemployment, overpopulation, and the threat of a nuclear war.**

Your position, basically: (Please read from A to I, and then choose one.)

- A. Science and technology can certainly help to resolve these problems. The problems could use new ideas from science and new inventions from technology.
- B. Science and technology can help resolve some social problems but not others.
- C. Science and technology solve many social problems, but science and technology also cause many of these problems.
- D. It's not a question of science and technology helping, but rather it's a question of people using science and technology wisely.
- E. It's hard to see how science and technology could help very much in resolving these social problems. Social problems concern human nature; these problems have little to do with science and technology.
- F. Science and technology only make social problems worse. It's the price we pay for advances in science and technology.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

- 40421** In your everyday life, knowledge of science and technology helps you personally solve practical problems (for example, getting a car out of a snowdrift, cooking, or caring for a pet.)

Your position, basically: (Please read from A to J, and then choose one.)

The systematic reasoning taught in science classes (for example, hypothesizing, gathering data, being logical):

- A. helps me solve some problems in my daily life. Everyday problems are more easily and logically solved if treated like science problems.
- B. gives me greater knowledge and understanding of everyday problems. However, the problem solving techniques we learn are not directly useful in my daily life.
- C. Ideas and facts I learn from science classes sometimes help me solve problems or make decisions about such things as cooking, keeping healthy, or explaining a wide range of physical events.
- D. The systematic reasoning and the ideas and facts I learn from science classes help me a lot. They help me solve certain problems and understand a wide variety of physical events (for example, thunder or quasars).
- E. What I learn from science class generally does not help me solve practical problems; but it does help me notice, relate to, and understand, the world around me.

What I learn from science class does not relate to my everyday life:

- F. biology, chemistry and physics are not practical for me. They emphasize theoretical and technical details that have little to do with my day-to-day world.
- G. my problems are solved by past experience or by knowledge unrelated to science and technology.
- H. I don't understand.
- I. I don't know enough about this subject to make a choice.
- J. None of these choices fits my basic viewpoint.

40451 We have to be concerned about pollution problems which are unsolvable today. Science and technology can not necessarily fix these problems in the future.

Your position, basically: (Please read from A to I, and then choose one.)

Science and technology can NOT fix such problems:

- A. because science and technology are the reason that we have pollution problems in the first place. More science and technology will bring more pollution problems.
- B. because pollution problems are so bad today they are already beyond the ability for science and technology to fix them.
- C. because pollution problems are becoming so bad that they may soon be beyond the ability of science and technology to fix them.
- D. No one can predict what science and technology will be able to fix in the future.
- E. Science and technology alone can not fix pollution problems. It is everyone's responsibility. The public must insist that fixing these problems is a top priority.
- F. Science and technology can fix such problems because the success at solving problems in the past means science and technology will be successful in the future at fixing pollution problems.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

40511 The more Canada's science and technology develop, the wealthier Canada will become.

Your position, basically: (Please read from A to H, and then choose one.)

Science and technology will increase Canada's wealth:

- A. because science and technology bring greater efficiency, productivity and progress.
- B. because more science and technology would make Canada less dependent on other countries. We could produce things for ourselves.
- C. because Canada could sell new ideas and technology to other countries for profit.
- D. It depends on which science and technologies we invest in. Some outcomes are risky. There may be other ways besides science and technology that create wealth for Canada.
- E. Science and technology decrease Canada's wealth because it costs a great deal of money to develop science and technology.
- F. I don't understand.
- G. I don't know enough about this subject to make a choice.
- H. None of these choices fits my basic viewpoint.

40521 High-technology industries will provide most of the new jobs in the next twenty years.

Your position, basically: (Please read from A to I, and then choose one.)

- A. Yes. New information and rapid change are the keys to society's future.
- B. Yes, because Canada's industries will have to become more efficient by installing hi-tech systems in order to compete.
- C. Yes, because new Canadian industries will produce hi-tech products. Public demand for these products will create new jobs.
- D. Yes. There will be many new jobs. Specially trained people will be needed to run and repair the new technology and to develop new kinds of hi-tech industries.
- E. Yes. Specially trained people will be needed to run and repair the new technology. BUT it will replace some of today's jobs. Overall, the total number of jobs will be about the same.
- F. No. Only a few new jobs will be created. More jobs will be lost because of mechanical or computerized hi-technology.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

40531 More technology will improve the standard of living for Canadians.

Your position, basically: (Please read from A to I, and then choose one.)

- A. Yes, because technology has always improved the standard of living, and there is no reason for it to stop now.
- B. Yes, because the more we know, the better we can solve our problems and take care of ourselves.
- C. Yes, because technology creates jobs and prosperity. Technology helps life become easier, more efficient and more fun.
- D. Yes, but only for those who can afford to use it. More technology will cut jobs and cause more people to fall below the poverty line.
- E. Yes and no. More technology would make life easier, healthier and more efficient. BUT more technology would cause more pollution, unemployment and other problems. The standard of living may improve, but the quality of life may not.
- F. No. We are irresponsible with the technology we have now; for example, our production of weapons and using up our natural resources.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

- 40611 **The most powerful countries of the world have military strength because of the country's superior science and technology.**

Your position, basically: (Please read from A to I, and then choose one.)

Military strength depends a great deal on science and technology:

- A. because the greater the development in science and technology, the more modern, accurate and destructive the weapons.
- B. because the military usually has a strong voice in government, and the military will insist on using science and technology to build its strength.
- C. because the more advanced the country's science and technology, the richer the country. Its money can be spent on making the military stronger.
- D. Military strength depends not only on science and technology for powerful weapons, but also on the size of its armed forces.
- E. Military strength depends partly on science and technology and partly on a government's decision to develop weapons to increase its power.
- F. Military strength does not depend on science and technology, but on the government. Some countries which are strong in science and technology have weak militaries (for example, Japan). Some countries which have a strong military are weak in science and technology (for example, China).
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

- 40711 **Science and technology influence our everyday thinking because science and technology give us new words and ideas.**

Your position, basically: (Please read from A to I, and then choose one.)

- A. Yes, because the more you learn about science and technology, the more your vocabulary increases, and thus the more information you can apply to everyday problems.
- B. Yes, because we use the products of science and technology (for example, computers, microwaves, health care). New products add new words to our vocabulary and change the way we think about everyday things.
- C. Science and technology influence our everyday thinking BUT the influence is mostly from new ideas, inventions and techniques which broaden our thinking.

Science and technology are the most powerful influences on our everyday lives, not because of words and ideas:

- D. but because almost everything we do, and everything around us, has in some way been researched by science and technology.
- E. but because science and technology have changed the way we live.
- F. No, because our everyday thinking is mostly influenced by non-scientific things. Science and technology influence only a few of our ideas.
- G. I don't understand.
- H. I don't know enough about this subject to make a choice.
- I. None of these choices fits my basic viewpoint.

- 60511 **There are many more women scientists today than there used to be. This will make a difference to the scientific discoveries which are made. Scientific discoveries made by women will tend to be different than those made by men.**

Your position, basically: (Please read from A to M, and then choose one.)

There is NO difference between female and the male scientists in the discoveries they make:

- A. because any good scientist will eventually make the same discovery as another good scientist.
- B. because female and male scientists experience the same training.
- C. because overall women and men are equally intelligent.
- D. because women and men are the same in terms of what they want to discover in science.
- E. because research goals are set by demands or desires from others besides scientists.
- F. because everyone is equal, no matter what they do.
- G. because any differences in their discoveries are due to differences between individuals. Such differences have nothing to do with being male or female.

- H. Women would make somewhat different discoveries because, by nature or by upbringing, females have different values, viewpoints, perspectives, or characteristics (such as sensitivity toward consequences).
- I. Men would make somewhat different discoveries because men are better at science than women.
- J. Women would likely make somewhat better discoveries than men because women are generally better than men at some things such as instinct and memory.

- K. I don't understand.
- L. I don't know enough about this subject to make a choice.
- M. None of these choices fits my basic viewpoint.

60531 **Male scientists concentrate only on the facts which support an idea. Female scientists in the lab ALSO pay attention to human values.**

Your position, basically: (Please read from A to K, and then choose one.)

There is NO difference between female and male scientists:

- A. because there is no room for human values in the lab. All good scientists pay attention only to the facts.
- B. because it takes intelligence to pay attention to values. Intelligence has nothing to do with being male or female.
- C. because it's a scientist's training which affects whether he or she pays attention to facts more than human values.
- D. because it's a scientist's individual personality which affects whether he or she pays attention to facts more than human values.
- E. because good scientists pay attention to both the facts and human values when in the lab.
- F. because female and male scientists are the same. Men are as sensitive to human values as women are and women are as logical with facts as men are.
- G. because everyone is equal no matter what the job.
- H. Female scientists are more likely to consider human values in research, as well as the facts.
- I. I don't understand.
- J. I don't know enough about this subject to make a choice.
- K. None of these choices fits my basic viewpoint.

60611 Today In Canada, there are many more male scientists than female scientists. The MAIN reason for this is:

Your position, basically: (Please read from A to K, and then choose one.)

- A. males are stronger, faster, brighter, and better at concentrating on their studies.
- B. males seem to have more scientific abilities than females, who may excel in other fields.
- C. males are just more interested in science than females.
- D. the traditional stereotype held by society has been that men are smarter and dominant, while women are weaker and less logical. This prejudice has caused more men to become scientists, even though females are just as capable in science as males.
- E. the schools have not done enough to encourage females to take science courses. Females are just as capable in science as males.
- F. until recently, science was thought to be a man's vocation. (Women didn't fit television's stereotype image of scientist.) In addition, most women were expected to work in the home or take on traditional jobs. (Thus men have had more encouragement to become scientists.) But today this is changing. Science is becoming a vocation for women, and women are expected to work in science more and more.
- G. women have been discouraged, or not allowed, to enter the scientific field. Women are just as interested and just as capable as men; but the established scientists (who are male) tend to discourage or intimidate potential female scientists.
- H. There are NO reasons for having more male scientists than female scientists. Both sexes are equally capable of being good scientists, and today the opportunities are equal.
- I. I don't understand.
- J. I don't know enough about this subject to make a choice.
- K. None of these choices fits my basic viewpoint.

- 80111** When a new technology is developed (for example, a new computer), it may or may not be put into practice. The decision to use a new technology depends mainly on how well it works.

Your position, basically: (Please read from A to K, and then choose one.)

- A. The decision to use a new technology depends mainly on how well it works. You don't use something unless it works well.
- B. The decision depends on several things, such as its cost, its efficiency, its usefulness to society, and its effect on employment.

The decision does NOT depend necessarily on how well it works:

- C. but on how cost effective it is.
- D. but on what society wants or needs.
- E. but on whether it helps the world and has no negative effects. New technologies are not used if they are harmful.
- F. but on whether the government in power supports its.
- G. but on whether it will make a profit for a company.
- H. because some technologies are put into practice before they work well. They are improved later.
- I. I don't understand.
- J. I don't know enough about this subject to make a choice.
- K. None of these choices fits my basic viewpoint.

- 80131** When a new technology is developed (for example, a new computer), it may or may not be put into practice. The decision to use a new technology depends on whether the advantages to society outweigh the disadvantages to society.

Your position, basically: (Please read from A to G, and then choose one.)

- A. The decision to use a new technology depends mainly on the benefits to society because if there are too many disadvantages, society won't accept it and may discourage its further development.
- B. The decision depends on more than just the technology's advantages and disadvantages. It depends on how well it works, its cost, and its efficiency.
- C. It depends on your point of view. What is an advantage to some people may be a disadvantage to others.
- D. Many new technologies have been put into practice to make money or gain power, even though their disadvantages were greater than their advantages.
- E. I don't understand.
- F. I don't know enough about this subject to make a choice.
- G. None of these choices fits my basic viewpoint.

APPENDIX D

TABLE 26 - 10311

Science and technology are important to the research and development (R&D) in Canadian industry. What does "research and development" mean to you?

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. R & D means finding new answers to questions about the world and about people	4.3	0.0	2.3	3.2	8.0	5.4
B. R & D means progress by making life easier and the quality of life better.	13	10	12	0.0	4.0	1.8
C. Research is exploring new facts, ideas and information. Development is putting them to use in order to benefit society.	17	20	18	48	28	39
D. Research is exploring new facts, ideas and information. Development is putting them to use by coming up with new and creative ideas.	0.0	20	9.3	13	28	20
E. R & D means exploring new ideas and problems in industry. In order to help and industry overcome its problems and thereby produce newer and better products.	13	10	12	13	8.0	11
F. R & D means a combination of science and technology. Research leads to development, and development leads to improved research.	13	10	12	6.5	8.0	7.0
G. R & D usually means helping humanity by finding medical cures and technologies. But unanticipated effects of R & D can also cause social problems.	4.3	0.0	2.3	0.0	0.0	0.0
H. R & D usually means helping humanity by finding medical cures and technologies. But R & D also means harming society by creating such things as nuclear arms and other wasteful technologies. It depends on the R & D or how it is used.	4.3	5.0	4.7	3.2	16	8.9
I. I don't understand.	17	5.0	12	0.0	0.0	0.0
J. I don't know enough about this subject to make a choice	8.7	15	12	9.7	0.0	5.4
K. None of these choices fits my basic viewpoint.	0.0	5.0	2.3	3.2	0.0	1.8

Note • 1 Grade 8 male did not respond

TABLE 27 - 10431
Technologists have their own body of knowledge to build on. Few developments in technology have come directly from discoveries made in science.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. Technology advances <u>mainly</u> on its own. It doesn't necessarily need scientific discoveries.	4.3	5.0	4.6	9.7	4.0	7.1
B. Technology advances by relying equally on <u>both</u> scientific discoveries and technology's own body of knowledge.	30	30	30	55	48	52
C. Both scientists and technologists depend on the same body of knowledge, because science and technology are so similar.	13	25	19	3.2	16	8.9
EVERY technological development builds on a scientific discovery:						
D. because scientific discoveries always find a use, whether for technological developments or for other scientific uses.	4.3	10	7.0	6.5	0.0	3.6
E. because science provides the background information and the new ideas for technology	8.7	5.0	7.0	16	20	18
F. I don't understand.	35	25	30	3.2	8.0	5.4
G. I don't know enough about this subject to make a choice.	0.0	0.0	0.0	6.5	4.0	5.4
H. None of these choices fits my basic viewpoint.	5.0	0.0	2.5	0.0	0.0	0.0

Note • 1 Grade 8 male did not respond

TABLE 28 - 20511
The success of science and technology in Canada depends on us having good scientists, engineers, and technicians. Therefore, Canada should require students to study more science in school.

Your position, basically:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	Total	N=31 Male	N=27 Female	N=58 Total
A. Students should be required to study more science because it is important for helping Canada to keep up with other countries.	13	5.0	9.3	3.2	8.0	5.4
B. Students should be required to study more science because science affects almost every aspect of society. As in the past our future depends on good scientists and technologists.	8.7	25	16	42	28	36
C. Students should be required to study more science, but a different kind of science course. Students should learn how science and technology affect their everyday lives.	8.7	25	16	9.7	16	13
D. Students should NOT be required to study more science, because other school subject are equally or more important to Canada's successful future.	8.7	5.0	7.0	19	16	18
E. Students should NOT be required to study more science, because it won't work. Some people don't like science. If you force them to study it, it will be a waste of time and will turn people away from science.	13	25	18	6.5	8.0	7.1
F. Students should NOT be required to study more science, because not all students can understand science, even though it would help them in their life.	0.0	5.0	2.3	6.5	4.0	5.4
G. Students should NOT be required to study more science, because not all students can understand science. Science is really not necessary for everyone.	0.0	0.0	0.0	0.0	4.0	1.8
H. Students should NOT be required to study more science, because it's not right for someone else to decide if a student should take more science.	17	0.0	9.3	6.5	12	8.9
I. I don't understand.	13	0.0	7.0	0.0	0.0	0.0
J. I don't know enough about this subject to make a choice.	13	5.0	9.3	3.2	0.0	1.8
K. None of these choices fits my basic viewpoint.	0.0	5.0	2.3	3.2	4.0	3.6

Note • 1 Grade 8 male did not respond

TABLE 29 - 20521

The success of science and technology in Canada depends on how much support the public gives to scientists, engineers, and technicians. This support depends on high school students - the future public - learning how science and technology are used in Canada.

Your position, basically:

Yes, the more students learn about science and technology:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. the better they will keep the country running. High school students are the future	4.3	20	12	9.7	4.0	7.1
B. the more students will become scientists, engineers, and technicians, and so Canada will prosper.	17	15	16	19	4.0	13
C. the more informed the future public will be. They will be able to form better opinions and make better contributions to how science and technology are used.	22	20	21	39	64	50
D. the more the public will see that science and technology are important. The public will better understand the views of experts and will provide the needed support for science and technology.	4.3	5.0	4.7	19	12	16
E. No, support does not depend on students learning more about science and technology. Some high school students are not interested in science subjects.	13	15	14	6.5	8.0	7.1
F. I don't understand.	17	10	14	0.0	4.0	1.8
G. I don't know enough about this subject to make a choice.	8.7	10	9.3	3.2	0.0	1.8
H. None of these choices fits my basic viewpoint.	4.3	0.0	2.3	3.2	4.0	3.6

Note

- 1 Grade 8 female did not respond
- 2 Grade 8 males did not respond

TABLE 30 - 40221

Science and technology can help people make moral decisions (that is, one group of people deciding how to act towards another group of people).

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. Science and Technology can help you make some moral decisions: by making you more informed about the people and the world around you. This background information can help you cope with moral aspect of life.	17	15	16	32	44	38
B. by providing background information; but moral decisions must be made by the individual.	4.3	30	16	32	8.0	21
C. because science includes areas like psychology which study the human mind and emotions	22	20	21	9.7	8.0	8.9
Science and technology cannot help you make moral decisions:						
D. because science and technology have nothing to do with moral decisions. Science and technology only discover, explain and invent things. What people do with the results is not the scientist or the engineer's concern.	8.7	15	12	6.5	4.0	5.4
E. because moral decisions are made solely on the basis of an individual's values and beliefs.	4.3	5.0	4.7	6.5	16	11
F. because if moral decisions are based on scientific information, the decisions often lead to racism, by assuming that one group of people is better than another group of people.	0.0	5.0	2.3	0.0	12	5.4
G. I don't understand.	17	5.0	12	6.5	0.0	3.6
H. I don't know enough about this subject to make a choice.	4.3	5.0	4.7	6.5	4.0	5.4
I. None of these choices fits my basic viewpoint.	13	0.0	7.0	0.0	4.0	1.8

Note • 2 Grade 8 male did not respond

TABLE 31 - 40231
Science and technology can NOT help people make legal decisions; for example, deciding if a person is guilty or not in a court of law.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
Science and technology can NOT help:						
A. because they have nothing to do with legal decisions, since legal decisions are based on moral values and beliefs.	4.3	20	12	9.7	24	16
B. because it's wrong to base legal decisions on technology such as a lie detector.	8.7	10	9.3	0.0	0.0	0.0
Science and technology CAN help in a number of cases:						
C. by developing ways to gather evidence and by testifying about the physical facts of a case.	39	20	30	68	44	57
D. by studying human behaviour and explaining the human circumstances of a case.	4.3	30	16	16	16	16
E. I don't understand.	26	50	16	0.0	4.0	1.8
F. I don't know enough about this subject to make a choice.	0.0	5.0	2.3	3.2	4.0	3.6
G. None of these choices fits my basic viewpoint.	8.7	10	9.3	3.2	8.0	5.4

Note • 2 Grade 8 male did not respond

TABLE 32 - 40311

We always have to make trade-offs (compromises) between the positive and negative effects of science and technology.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
There are always trade-offs between benefits and negative effects:						
A. because every new development has at least one negative result. If we didn't put up with the negative results, we would not progress to enjoy the benefits	4.3	15	9.3	9.7	36	21
B. because scientists cannot predict the long-term effects of new developments. In spite of careful testing and planning. We have to take a chance.	0.0	40	18	19	20	20
C. Because things that benefit some people will be negative for someone else. This depends on a person's viewpoint.	8.7	5.0	7.0	9.7	8.0	8.9
D. because you can't get positive results without first trying out a new idea and then working out its negative effects.	4.3	5.0	4.7	16	16	16
E. but the trade-offs make no sense. (for example: why invent labour saving devices which cause more unemployment? or Why defend a country with nuclear weapons which threaten the life of the earth.	8.7	5.0	7.0	9.7	4.0	7.1
There are NOT always trade-offs between benefits and negative effects:						
F. because new developments benefit us without producing negative effects.	0.0	0.0	0.0	0.0	0.0	0.0
G. because negative effects can be minimized through careful planning and testing.	22	15	18	19	0.0	10.7
H. because negative effects can be eliminated through careful planning and testing. Otherwise, a new development is not used.	4.3	0.0	2.3	3.2	0.0	1.8
I. I don't understand.	17	5.0	12	6.5	0.0	3.6
J. I don't know enough about this subject to make a choice.	0.0	10	4.7	6.5	4.0	5.4
K. None of these choices fits my basic viewpoint.	22	0.0	12	0.0	12	5.4

Note • 2 Grade 8 males did not respond

TABLE 33 - 40321

More money should be spent on science and technology in Canada even though this money will not be available for other things, such as social programs, education, business incentives, lower taxes.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
MORE money should be spent on science and technology:						
A. so Canada can be competitive with the rest of the world.	8.7	10	9.3	9.7	0.0	5.4
B. so Canadians' daily lives can be improved; for example, by making things easier to do, creating new industries and jobs, helping the economy, and solving health problems.	13	35	26	16	8.0	13
C. but only if the money is spent on such things as curing diseases, working on pollution, or improving the food supply for the starving.	4.3	10	7.0	13	12	13
D. the money should be spent in a balanced way as it is today. Science and technology are very important but they are not the only things that need money for progress in Canada.	22	15	18	42	56	48
E. LESS money should be spent on science and technology so more money is available for such things as social programs, education, business incentives and lower taxes.	8.7	5.0	7.0	6.5	16	11
F. I don't understand.	13	10	12	0.0	0.0	0.0
G. I don't know enough about this subject to make a choice.	4.3	5.0	4.7	6.5	8.0	7.1
H. None of these fits my basic viewpoint.	13	5.0	9.3	6.5	0.0	3.6

Note

- 3 Grade 8 male did not respond
- 1 Grade 8 female did not respond

TABLE 34 - 40421

In your everyday life, knowledge of science and technology helps you personally solve practical problems (for example, getting a car out of a snowdrift, cooking, or caring for a pet).

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
The systematic reasoning taught in science classes (ie. hypothesizing, gathering data): helps me solve some problems in my everyday life. Everyday problems are more easily and logically solved if treated like science problems.	13	30	21	19	4.0	12
B. gives me greater knowledge and understanding of everyday problems. However, the problem solving techniques we learn are not directly useful in my daily life.	17	20	18	23	20	21
C. Ideas and facts I learn from science classes sometimes help me solve problems or make decisions about such things as cooking, keeping healthy, or explaining a wide variety of physical events.	13	0.0	7	19	20	20
D. The systematic reasoning and the ideas and facts I learn from science classes help me a lot. They help me solve certain problems and understand a wide variety of physical events (for example, thunder or quosars).	13	5.0	9.3	9.7	16	13
E. What I learn from science class generally does not help me solve practical problems; but it does help me notice, relate to, and understand, the world around me.	4.3	5.0	4.7	13	16	14
What I learn from science class does not relate to my everyday life:						
F. biology, chemistry, and physics are not practical for me. They emphasize theoretical and technical details that have little to do with my day-to-day world.	0.0	5.0	2.3	6.5	12	8.9
G. my problems are solved by past experience or by knowledge unrelated to science and technology.	4.3	10	7.0	3.2	8.0	5.4
H. I don't understand.	22	5.0	14	3.2	4.0	3.6
I. I don't know enough about this subject to make a choice.	4.3	10	7.0	3.2	0.0	1.8
J. None of these choices fits my basic viewpoint.	8.7	10	9.3	0.0	0.0	0.0

Note • 2 Grade 8 female did not respond
• 1 Grade 8 male did not respond

TABLE 35 - 40511
The more Canada's science and technology develop, the wealthier Canada will become.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
Science and technology will increase Canada's wealth:						
A. because science and technology bring greater efficiency, productivity and progress.	13	10	12	32	24	29
B. because more science and technology would make Canada less dependent on other countries. We could produce things for ourselves.	0.0	25	12	9.7	16	13
C. because Canada could sell new ideas and technology to other countries for profit.	8.7	15	12	6.5	0.0	3.6
D. It depends on which science and technologies we invest in. Some outcomes are risky. There may be other ways besides science and technology that create wealth for Canada.	13	10	12	29	40	34
E. Science and technology decrease Canada's wealth because it costs a great amount of money to develop science and technology.	8.7	10	9.3	6.5	16	11
F. I don't understand.	35	0.0	18	6.5	0.0	3.6
G. I don't know enough about this subject to make a choice.	8.7	15	12	6.5	4.0	5.4
H. None of these choices fits my basic viewpoint.	8.7	5.0	7.0	3.2	0.0	1.8

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 females did not respond

TABLE 36 - 40521
High-technology industries will provide work for most of the new jobs in the next twenty years.

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
Your position, basically:						
A. Yes. New information and rapid change are the keys to society's future.	13	20	16	9.7	0.0	5.4
B. Yes, because Canada's industries will have to become more efficient by installing hi-tech systems in order to compete.	13	15	14	23	8.0	16
C. Yes, because new Canadian industries will produce hi-tech products. Public demand for these products will create new jobs.	4.3	5.0	4.7	19	8.0	14
D. Yes. There will be many new jobs. Specially trained people will be needed to run and repair the new technology and to develop new kinds of hi-tech industries.	13	10	12	9.7	28	18
E. Yes. Specially trained people will be needed to run and repair the new technology, BUT it will replace some of today's jobs. Overall, the total number of jobs will be about the same.	4.3	20	12	9.7	24	16
F. No. Only a few new jobs will be created. More jobs will be lost because of mechanical or computerized hi-technology.	4.3	5.0	4.7	16	28	21
G. I don't understand.	26	0.0	14	6.5	0.0	3.6
H. I don't know enough this subject to make a choice.	8.7	5.0	7.0	3.2	4.0	3.6
I. None of these choices fits my basic viewpoint.	8.7	10	9.3	3.2	0.0	1.8

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 females did not respond

TABLE 37 - 40531
More technology will improve the standard of living for Canadians.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. Yes, because technology has <u>always</u> improved the standard of living, and there is no reason for it to stop now.	22.0	0.0	12.0	16.0	4.0	11.0
B. Yes, because the more we know, the better we can solve our problems and take care of ourselves.	17.0	20.0	18.0	29.0	12.0	21.0
C. Yes, because technology creates jobs and prosperity. Technology helps life become easier, more efficient and more fun.	4.3	25.0	14.0	23.0	28.0	25.0
D. Yes, but only for those who can afford to use it. More technology will cut jobs and cause more people to fall below the poverty line.	4.3	5.0	4.7	0.0	4.0	1.8
E. Yes and no. More technology will make life easier, healthier and more efficient. BUT more technology will cause more pollution, unemployment and other problems. The standard of living may improve, but the quality of life may not.	8.7	25.0	16.0	23.0	44.0	32.0
F. No. We are irresponsible with the technology we have now; for example, our production of weapons and using up our natural resources.	4.3	5.0	4.7	6.5	4.0	5.4
G. I don't understand.	17.0	0.0	9.3	3.2	0.0	1.8
H. I don't know enough about this subject to make a choice.	13.0	10.0	12.0	0.0	4.0	1.6
I. None of these choices fits my basic viewpoint.	4.3	0.0	2.3	0.0	0.0	0.0

Note

- 1 Grade 8 male did not respond
- 2 Grade 8 females did not respond

TABLE 38 - 40611
The most powerful countries in the world have military strength because of the country's superior science and technology.

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23		N=45 Total	N=31		N=58 Total
	Male	Female		Male	Female	
Your position, basically:						
Military strength depends a great deal on science and technology:						
A. Because the greater the development in science and technology, the more modern accurate and destructive the weapon.	17	25	21	43	32	38
B. because the military usually has a strong voice in government, and the military will insist on using science and technology to build its strength.	8.7	10	9.3	19	12	16
C. because the more advanced the country's science and technology, the richer the country. Its money that can be spent on making the military stronger.	4.3	10	7.0	3.2	4.0	3.6
D. Military strength depends not only on science and technology for powerful weapons, but also on the size of its armed forces.	13	10	12	13	12	13
E. Military strength depends partly on science and technology and partly on a government's decision to develop weapons to increase its power.	4.3	5.0	4.7	6.5	16	11
F. Military strength does not depend on science and technology, but on the government. Some countries which are strong in science and technology have weak militaries (ie. Japan), and some have a strong military but are weak in science and technology.	8.7	15	12	3.2	16	8.9
G. I don't understand.	22	0.0	12	3.2	0.0	1.8
H. I don't know enough about this subject to make a choice.	8.7	15	12	3.2	8.0	5.4
I. None of these choices fits my basic viewpoint.	8.7	0.0	4.7	6.5	0.0	3.6

Note

- * 1 Grade 8 male did not respond
- * 2 Grade 8 females did not respond

TABLE 39 - 40711
Science and technology influence our everyday thinking because science and technology give us new words and ideas.

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
Your position, basically:						
A. Yes, because the more you learn about science and technology, the more your vocabulary increases, and thus the more information you can apply to everyday problems.	13	5.0	9.3	13	24	18
B. Yes, because we use the products of science and technology (for example, computers, microwaves, health care). New products add new words to our vocabulary and change the way we think about everyday things.	17	25	21	29	20	25
C. Science and technology influence our everyday thinking BUT the influence is mostly from new ideas, inventions and techniques which broaden our thinking.	13	15	14	29	16	23
Science and technology are the most powerful influence on our everyday lives, not because of words and ideas:						
D. but because almost everything we do, and everything around us, has in some way been researched by science and technology.	0.0	0.0	0.0	9.7	16	13
E. but because science and technology have changed the way we live.	4.3	20	12	3.2	8.0	5.4
F. No, because our everyday thinking is mostly influenced by non scientific things, science and technology influence only a few of our ideas.	4.3	5.0	4.7	3.2	8.0	5.4
G. I don't understand.	22	5.0	14	6.5	0.0	3.6
H. I don't know enough about this subject to make a choice.	4.3	10	7.0	3.2	4.0	3.6
I. None of these choices fits my basic viewpoint.	17	5.0	12	3.2	4.0	3.6

Note

- 2 Grade 8 females did not respond
- 1 Grade 8 male did not respond

TABLE 40 - 60611
Today in Canada, there are many more male scientists than female scientists. The MAIN reason for this is :

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. males are stronger, faster, brighter, and better at concentrating on their studies.	4.3	0.0	2.3	6.5	0.0	3.6
B. males seem to have more scientific abilities than females, who may excel in other fields.	4.3	10	7.0	9.7	0.0	5.4
C. males are just more interested in science than females.	22	35	28	6.5	8.0	7.1
D. the traditional stereotype held by society has been that men are smarter and dominant, while women are weaker and less logical. This prejudice has caused more men to become scientists, even though females are just as capable in science as males.	0.0	0.0	0.0	35	16	27
E. the schools have not done enough to encourage females to take science courses. Females are just as capable in science as males.	8.7	10	9.3	6.5	8.0	7.1
F. Until recently, science was thought to be a man's vocation. In addition, most women were expected to work in the home or take on traditional jobs. Men had more encouragement to become scientists. But this is changing. Science is becoming a vocation for women.	4.3	0.0	2.3	6.5	40	21
G. women have been discouraged, or not allowed, to enter the scientific field. Women are just interested and are just as capable as men; but the established scientists (who are generally male) tend to discourage or intimidate potential female scientists.	4.3	5.0	4.7	6.5	12	8.9
H. There are NO reasons for having more male scientists than female scientists. Both sexes are equally capable of being good scientists, and today opportunities are equal.	17	5.0	12	13	16	14
I. I don't understand.	17	10	14	6.5	0.0	3.6
J. I don't know enough about this subject to make a choice.	8.7	5.0	7.0	3.2	0.0	1.8
K. None of these choices fits my basic viewpoint.	4.3	5.0	4.7	0.0	0.0	0.0

TABLE 41 - 80111

When a new technology is developed (for example, a new computer), it may or may not be put into practice. The decision to use technology depends mainly on how well it works.

Your position, basically:	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. The decision to use technology depends <u>mainly</u> on how well it works. You don't use something unless it works well.	13	5.0	9.3	23	8.0	16
B. The decision depends on several things, such as its cost, its efficiency, its usefulness to society, and its affect on employment.	4.3	25	14	29	48	38
The decision does NOT depend necessarily on how well it works:						
C. but on how cost efficient it is.	4.3	5.0	4.7	3.2	4.0	3.6
D. but on what society wants or needs.	0.0	10	4.7	6.5	8.0	7.1
E. but on whether it helps the world and has no negative effects. New technologies are not used if they are harmful.	8.7	10	9.3	9.7	0.0	5.4
F. but on whether it will make profit for a company.	4.3	0.0	2.3	9.7	4.0	7.1
H. because some technologies are put into before they work well.	4.3	5.0	4.7	0.0	4.0	1.8
I. I don't understand.	17	5.0	12	6.5	0.0	3.6
J. I don't know enough about this subject to make a choice.	8.7	10	9.3	9.7	4.0	7.1
K. None of these choices fits my basic viewpoint.	22	10	16	3.2	12	7.1

Note

- 2 Grade 8 male did not respond
- 3 Grade 8 females did not respond

TABLE 42 - 80131

When a new technology is developed (for example, a new computer), it may or may not be put into practice. The decision to use a technology depends on whether the advantages to society outweigh the disadvantages to society.

Your position, basically:

	EIGHTH GRADE			ELEVENTH GRADE		
	N=23 Male	N=22 Female	N=45 Total	N=31 Male	N=27 Female	N=58 Total
A. the decision to use a technology depends mainly on the benefits to society because if there are too many disadvantages, society won't accept it and may discourage its further development.	13	10	12	16	16	16
B. The decision depends on more than just the advantages and disadvantages. It depends on how well it works, its cost, and its efficiency.	8.7	15	12	45	28	38
C. It depends on your point of view. What is an advantage to some people may be a disadvantage to others.	13	20	16	13	12	13
D. Many technologies have been put into practice to make money or gain power, even though their disadvantages were greater than their advantages.	13	0.0	7.0	9.7	24	16
E. I don't understand.	17	10	14	3.2	4.0	3.6
F. I don't know enough about this subject to make a choice.	8.7	15	12	6.5	12	8.9
G. None of these choices fits my basic viewpoint.	17	15	16	6.5	4.0	5.4

Note

- 2 Grade 8 males did not respond
- 3 Grade 8 females did not respond

APPENDIX E

STUDENT BACKGROUND INFORMATION
QUESTIONNAIREPERSONAL INFORMATION

1. Name _____
2. I am (1) female (2) male .
3. I am _____ years old.
4. I am in Grade _____ .
5. Mother's occupation: _____.
6. Father's occupation: _____.

GENERAL INFORMATION

1. What is science?
2. What is technology?
3. Do you like science?
Yes _____ No _____ Neither like nor dislike _____
If yes, why do you like science?

If no, why don't you like science?
4. Describe your science background.
5. Do you ever talk about science or technology at Home?

6. How comfortable are you in the science classroom?

7. Do you like to watch science programs on television?

Yes _____ No _____

If yes, which ones?

8. Have you participated in any school field trips that were scientific in nature?

Yes _____ No _____

If yes, where did you go?

Did you enjoy the trip?

Yes _____ No _____

If yes, why did you enjoy the trip?

If no, why didn't you enjoy the trip?

9. Have you been exposed to any scientific/technological role models through school related activities? For example: Engineers, Doctors, Nurses, Lab Technicians, Computer Technologists.

Yes _____ No _____

If yes, describe the types of role models you have been exposed to.

If no, would you have liked to have been exposed to scientific/technological role models?

Yes _____ No _____

If yes, which kinds of scientific/technological role models would you like to be exposed to?

10. Do you remember your parents taking you on scientific or technological adventures?

Yes _____ No _____

If yes, where did they take you?

Examples: The Space Sciences Centre, the Devonian Botanical Garden, The Muttart Conservatory, The City of Edmonton Water Treatment Plant, John Janzen Nature Centre.

If no, would you have liked to have participated in a scientific or technological adventure?

Yes _____ No _____

If yes, where would you have liked to have gone?

11. What kinds of toys were you encouraged to play with when you were young?
12. What games do you like to play?
13. What are your favorite leisure activities?
14. What are your plans for the future?
15. What career do you wish to pursue?
16. Are you planning on pursuing post-secondary education? For example, University, NAIT, Grant MacEwan Community College, Concordia College, The Alberta College of Art.
- Yes _____ No _____
- If yes, what Faculty do you plan to register in?
17. What do you think should be taught in science classes?
18. How do you think science should be taught in schools?
19. How can science teachers make the science classroom more interesting for science students?

Appendix F

Student Responses to Items #1, #2, #3, #15, #17, and #19 from the Student Background Questionnaire.

Grade 11 responses to Item 10 from the Student Background Questionnaire have been included as well. Grade 3, Grade 8 and Science 24 students did not identify that they were interested in being exposed to any particular scientific/technological role models, thus there were no responses to report.

Item #1 - Grade 3 - Males

What is science?

- science is where you learn experimemts.
- science is eckperemeting whith stuf.
- exsparamenting.
- it's expieriments.
- science is a thing you do with exeroments.
- something you do with exparaments.
- finding new things, mixing cemicals.
- it is when you have cemikels and you mikes.
- something you disgovor.
- it's something that you test and see what happens.
- studing things that arent farmilure with people.
- science is what you du sumsing intrastest.
- you lern about things.
- its something that you lern.
- it is like lerning about light.
- something to find out something else.

Item #1 - Grade 3 - Females

What is science?

- doing issprimds.
- exsporamenting.
- you do some experement.
- science is when you do experaments.
- science is when you do experements.
- it is some experement.
- is when you try to discover something you try to figure out.
- science is learning about things.
- when you lern stuff.

Item #1 - Grade 8 - Males**What is science?**

- science is learning about the earth and its materials.
- it is learning about the earth.
- the study of life and everything we interact with.
- science is the study of our world and how it works.
- the study of the environment around us and the factors that affect us.
- a job that deals with finding and understanding strange things.
- the study of plants, animals, cells.
- the study of almost everything. eg. medicine.
- science is the study of everything around us.
- the study of everything.
- the study of everything.
- the study of everything.
- science is the study of technology.
- science is asking and answering questions.
- science answers the questions that other things can't.
- it is a study to answer the questions that are yet unsolved.
- science answers the questions.
- I don't know.
- some dumb subject.

Item #1 - Grade 8 - Females**What is science?**

- science is the study of the environment, making decisions, and technology.
- the study of the environment and what goes on inside.
- science is the study of the environment.
- science is the study of life and the outdoors. Some science is medicine.
- the study of human nature and technology.
- the study of human nature and technology.
- the study of living things and chemicals.
- science is the study of the world and how it functions the way it does.
- the study of things, the way they work, and why they work the way they do.
- the study of certain things and the way they work and act.
- learning about how things are made up.
- science is like experimenting different things.
- science is experimenting.
- experimenting things.
- everything.
- is about asking a questions and getting it answered with facts and experiments.
- subject.
- subject.
- subject.

Item #1 - Grade 11 - Biology - Males**What is science?**

- the study and explanation of the world around us.
- the study of our world and how it works.
- the study of how the elements of our earth function together.
- the study of the nature of the universe.
- science is the study of known and unknown relationships in the universe in which we live.
- it is the different studies of organisms in their environments.
- the study of life occurrences.
- the learning of the fundamentals of life and the world around us.
- science is to explain why things are the way they are. Why things happen and the way they do.
- knowledge of why things happen.
- finding out about new and old things.
- the study of technology.

Item #1 - Grade 11 - Physics - Males**What is science?**

- the study of the world around you.
- study of world around us.
- the study of the world around us.
- the study of our world.
- exploring, experimenting, gathering information, creating theories to explain the world.
- the study of the universe.
- is the study of how things work in our universe.
- is the study of biological happenings in the universe.
- the exploration of the universe.
- science is the process of finding and solving problems in a society.
- technology.
- study of new and old technology.
- a study of properties of chemicals, animals and states.
- 7 letter word.

Item #1 - Grade 11 - Science 24 - Males**What is science?**

- the study of plants, animals and other micro-organisms.
- the study of animals, plants, the universe and the ecology.
- learning on animals, what makes them work, learning new things.
- what goes on in nature. eg. weather changes, life, universe, etc..
- the studies of the world and the universe.
- science is the study of nature.
- the study of something.
- the never ending questions. How? / Why?
- the never ending question.

Item #1 - Grade 11 - Biology - Females**What is science?**

- science to me is the study of living things like the world and everything that lives in it.
- it's the study of all living and non-living matter.
- the study of living organisms and the unknown.
- the study of animal life, organisms and bacteria.
- a subject studying and explaining the unknown.
- the study of our universe (existence).
- finding out WHY things are the way they are.
- a body of knowledge. We use it to understand our world.

Item #1 - Grade 11 - Physics - Females**What is science?**

- the study of physics, biology and chemistry. The world around us.
- science is the study of the physical world and philosophy in the world of nature and the universe.
- study of animals, technology, people, trends, etc..
- science is knowledge on how things work in the natural world.
- it is the study of things around you and in you.
- discovering new things in all aspects of life.
- I really don't know.

Item #1 - Grade 11 - Science 24 - Females**What is science?**

- science is many types of studies, like ecology, genetics and biology.
- animals, etc.

Item #2 - Grade 3 - Males**What is technology?**

- computer and other machines nolage
- coputors and electronics
- building things

The remaining grade three male students circled the word technology. Circling identifies that they did not feel comfortable defining this particular word because they felt they did not understand what it was.

Item #2 - Grade 3 - Females**What is technology?**

All grade three female students circled the word technology. This identifies that they did not feel comfortable defining this particular word because they felt they did not understand what it was.

Item #2 - Grade 8 - Males**What is technology?**

- advancements / changes in science.
- advancements and changes in anything.
- inventions / advancements / upgrades in science.
- inventions based on science.
- it is the inventions that are quite often the result of science.
- stating a science idea and putting it to use.
- it is taking a science idea and putting it to work.
- taking a science theory and making it useful. (eg. electricity making things run.)
- technology is a science idea.
- technology is science.
- the study of machinery.
- machines that we use every day of the week.
- changes and upgrades on anything.
- upgrades of everything.
- it is taking something like solar energy and learning to use it.
- some cool thing.
- some dumb cool stuff.
- I don't know.

Item #2 - Grade 8 - Females**What is technology?**

- technology is taking a science idea and making something of it.
- it is taking a science idea and doing something with it.
- taking a science idea and doing something with it.
- taking a science idea and making use of it wisely.
- advance an idea.
- technology is new ideas and inventions and principals.
- the inventions that are made by science.
- the machines made by inventors and finding ways to do things.
- Making things useful.
- to take something and make it better and more efficient, or something new which will help in science.
- the results of your experiments.
- technology is something to help you.
- the future of science.
- the future of science.
- the future of science.
- science principal.

Item #2 - Grade 11 - Biology - Males**What is technology?**

- the application of science.
- the application of science.
- the application of new scientific discoveries.
- advancements that improve our quality of life.
- technology is the advancement of science in fields such as electronics, engineering and such.
- new and improved ways to do things.
- improvement in industrialization.
- is the growth of tools and other materials.
- it is the machines that result from the results of science.
- computers, modern inventions.

Item #2 - Grade 11 - Physics - Males**What is technology?**

- the application of science, especially in creating machines.
- the application of science.
- the application of what you explore and find out.
- new science.
- new science.
- the discoveries of science.
- advancement of science.
- becoming more advanced due to research and knowledge.
- scientific advancements put to use.
- is the development of objects, things.
- is something we learn to improve our world.
- technology is the process of creating an environment the can ease society.
- the ability to study the universe.
- 10 letter word.

Item #2 - Grade 11 - Science 24 - Males**What is technology?**

- it is the application of science.
- application of science.
- the application of science.
- technology is the application of science, devices, etc. that make life easier.
- application of science.
- is the application of science.
- is science put to use to make life easier and better for mankind.
- the mechanical results corresponding to the knowledge of science. eg. science = disease / technology = cure.
- the advancing of mankind.
- the T.V. remote control.
- new machines

Item #2 - Grade 11 - Biology - Females**What is technology?**

- science in use.
- application of science.
- the application and development of science.
- the application of mechanical sciences to make machines for our use.
- the computers and machines that help to support the society.
- computers
- the new and upcoming ideas and machinery that make our lives easier - sometimes complicated - and also can save lives like medicine.
- growing technical industry.

Item #2 - Grade 11 - Physics - Females**What is technology?**

- the application of science to objects
- technology is the application of science to make machines, etc..
- it is science applied to make things.
- applying science to improve life.
- new inventions brought about through the study of science.
- technology is the development of tools used to further progress the human society.
- I don't know.

Item #2 - Grade 11 - Science 24 - Females**What is technology?**

- the study of how things work and how these things are made to benefit humans.

Item #3 - Grade 3 - Males**Why do you like science?**

- because it's fun.
- it is very fun.
- it is fun.
- it's fun.
- because its fun and you learn.
- because we eckperemet whith stufe.
- because of experaments.
- because we get to do exparaments.
- because you can learn alot.
- I like to lern things.
- because you discover stuf.
- becas you haf tu mace somsing wat wurks.
- because you never know what is going to happen.
- because you get a break from math.

Item #3 - Grade 3 - Females**Why do you like science?**

- cause you can do fun stuff.
- it is fun.
- it is fun doing the issprimds.
- because its fun.
- because it is fun.
- because it's fun to test things.
- because you get to do new things.
- because you learn deferint things.
- because you can learn a experement.
- because you get to figure out something nobody nows.
- because you can make all diffrent cinds of stuff.
- I like working with thinks.

Item #3 - Grade 3 - Females**Why don't you like science?**

- because it is boring.

Item #3 - Grade 8 - Males**Why do you like science?**

- because you learn alot about the earths surprises.
- it is interesting.
- it's interesting to find out more.
- it's interesting.
- it is interesting.
- it is an interesting subject that is quite neat.
- I like science because I am good at it and because science is interesting.
- it is an interesting subject area and you can exparement.
- science is fun because we get to do labs.
- cause its cool.
- it fascinates me.
- learn things, it's fun, so many different areas to study.

Why don't you like science?

- its gross.

Note:

Eight students reported that they neither liked or disliked science.

Item #3 - Grade 8 - Females**Why do you like science?**

- the labs.
- science is interesting and may help in the future.
- I think it is neat.
- because you learn lots of new things.
- because it's pretty easy.

Why don't you like science?

- because I don't get to dissect anything.
- the written work and analyzing.
- because it's not my type of subject.
- it is boring.
- I find it boring.
- it's boring.

Note:

Eleven students reported that they neither liked or disliked science.

Item #3 - Grade 11 - Biology - Males**Why do you like science?**

- it is interesting.
- it is interesting.
- it is interesting.
- it's very interesting.
- because it is interesting.
- it is interesting, and can explain all sorts of different phenomena.
- it has a broad field in which to study and is fascinating.
- it helps me understand how our earth functions.
- I learn how things happen and why.
- learn it easily.

Why don't you like science?

- because I like art.

Note:

Two students reported that they neither liked or disliked science.

Item #3 - Grade 11 - Physics - Males**Why do you like science?**

- I'm interested in the world around me and I believe that science has the potential to improve our quality of life and solve various problems facing the world.
- find it interesting.
- because it is interesting.
- I find it interesting to learn about what makes up our world.
- it is fascinating to understand the world's physical mechanisms.
- it is fascinating in all fields of it.
- it is a hands on subject and that makes it fun to learn.
- experimentation and the mathematical part.
- learn new things.
- learn new technology.
- there is no grey area. It's either there or it isn't.

Note:

Two students reported that they neither liked or disliked science.

Item #3 - Grade 11 - Science 24 - Males**Why do you like science?**

- because I've always liked to do experiments.
- I enjoy experimenting with new things.
- I enjoy doing labs.
- It's interesting, good to know.
- you do interesting stuff.
- I like science because I am interested in how the world turns.
- I have a big imagination and am very curious.
- I enjoy all kinds of animals.
- I like learning about how certain animals live.
- like to study why and how things happen in the world.
- because I learn about things.

Why don't you like science?

- too many things and big words to remember.

Note: One student reported that he neither liked or disliked science.

Item #3 - Grade 11 - Biology - Females**Why do you like science?**

- Interesting. Explains things. Tells me why, not just memorize that something happens.
- I am interested in biology.
- you learn new and interesting things.
- It's neat, you get to learn some interesting things and go on field trips and do labs you never get to do in other classes.
- I like to understand how things around us come to be, what they are and how they work.
- you learn things you were real curious about.
- I like it because I love animals and learning about the human body. I like the history and the mysteries and the beauties that life holds.

Why don't you like science?

- because it uses numbers and I hate math. (I don't hate biology.)

Item #3 - Grade 11 - Physics - Females**Why do you like science?**

- I find it interesting and a challenge.
- interesting and fun.
- interesting, set rules, can be proved wrong.
- it can be interesting.
- it is interesting.
- easy to understand / logical.

Why don't you like science?

- it's boring and I'm not planning on making a career out of it.

Note: Three students reported that they neither liked nor disliked science.

Item #3 - Grade 11 - Science 24 - Females**Why do you like science?**

- because it is interesting.
- I learn how things happen and why.

Why don't you like science?

- I find it boring.

Note:

Three students reported that they neither liked or disliked science.

Item #10 - Grade 11 - Biology - Males

What scientific/technological role models would you like to be exposed to?

- Marine Biologist
- police science
- Zoologist
- Engineer
- Doctor
- Nuclear Physics / Chemistry / Biochemistry
- Computers
- Biologists and Chemists
- Engineer

Item #10 - Grade 11 - Physics - Males

What scientific/technological role models would you like to be exposed to?

- Engineers
- Computer Engineers
- Doctors /Chemists
- Computer Analyst / Lab Technician / Technologists
- Doctors
- Computer People
- Engineer
- Computer Technologists / Scientists / Engineers
- Scientists / Doctors

Item #10 - Grade 11 - Biology - Females

What scientific/technological role models would you like to be exposed to?

- Lab Technicians
- Nurses
- Engineers
- Ecologists
- Doctors
- Archeologist
- Biologist
- Research Scientist

Item #10 - Grade 11 - Physics - Females

What scientific/technological role models would you like to be exposed to?

- Systems Analyst
- Any
- Surgeons
- Engineers
- Chemists
- Doctors
- Computer Technologists

Item #15 - Grade 3 - Males

What career do you wish to pursue?

- a piolet.
- a pilete.
- a ploie men.
- Police man.
- Detective.
- sicetist.
- to be a sciantict.
- Docter.
- Being a Vet or Cop.
- Ostrnot.
- Artest.
- Art /Library.
- Baseball player.
- Univesety.
- To be rich.
- I don't know.

It should be noted that the grade three students sometimes had difficulty responding to some of the items. This was because they were not able to comfortably comprehend some of the terminology used. For this item two male students circled the words career and pursue.

Item #15 - Grade 3 - Females**What career do you wish to pursue?**

- Be a teacher or lawyer.
- A teacher or a Lawyer.
- Teacher.
- A Teacher.
- Teacher.
- Doctor.
- I might want to be a Nurse or a Bally Teacher.
- Stewardest.
- Lawer / Judge
- To be a hairdresser.

It should be noted that the grade three students sometimes had difficulty responding to some of the items. This was because they were not able to comfortably comprehend some of the terminology used. For this item two female students circled the words career and pursue.

Item #15 - Grade 8 - Males**What career do you wish to pursue?**

- Doctor/Business
- Doctor
- Doctoring
- a Doctor
- Doctor/Lab Technician
- Medicine
- Dentist/Doctor/Lawyer
- a Dentist or a Comedian
- Neuro-Surgery
- Marine Biologist/Scuba Gear Diver
- Forest Ranger
- Forest Conservation
- Engineer
- Lawyer
- a Law Career
- Pro Hockey
- Hockey
- Professional Sports
- a Basketball Career
- Actor
- I'm not sure.
- I don't know.
- not sure.

Item #15 - Grade 8 - Females**What career do you wish to pursue?**

- Doctor/Nurse
- one in the Medical Field
- Surgeon/Pilot
- Veterinarian
- Vet.
- Pharmacist
- Dentistry
- I want to be a Policeman.
- Air Traffic Control/Military Police
- Air Traffic Controller (in the military) or a Military Police Officer
- fly a plane or drive a plane
- Law
- to be a counsellor
- to work in the bank or with kids
- Decrater
- Stewartist or Lawyer
- Riding Instructor/Trainer/Stable Manager/Professional Equestrienne
- undecided at the moment
- don't know yet

Item #15 - Grade 11 - Biology**What career do you wish to pursue?****Males**

- marine biology
- police scientist or comic artist
- police officer
- science of some sort
- unsure
- pharmacist
- mechanics
- medical
- social worker/cook/actor
- science education
- accountant
- biology/zoology
- physical education teacher
- pharmacist

Females

- a paramedic
- music productions
- nurse
- social worker
- law / political science
- police officer
- corporate law
- teacher
- I don't know

Item 15 - Grade 11 - Physics**What career do you wish to pursue?****Males**

- business
- drafting/engineer -doctor
- something with bikes
- pilot
- musician/songwriter
- science
- chemistry or computers
- business
- science/business/technology
- computer engineering
- computer engineering
- architect/auto engineer
- engineering/business
- marketing

Females

- systems analyst
- accountant
- business
- ???????
- occupational therapy
- paramedic
- undecided

Item #15 - Grade 11 - Science 24**What career do you wish to pursue?****Males**

- carpentry.
- carpentry.
- architecture or interior design.
- mechanic.
- be a mechanic.
- mechanic.
- small engine repair.

Females

- an accountant
- accounting
- possibly a career in the sciences or business
- hairstyling

Item #17 - Grade 3 - Males**What do you think should be taught in science classes?**

- cemicals.
- camastry.
- cemestry.
- exsparements.
- in the lab.
- all about animals how they live and plants.
- planting.
- electrecety, magnetiks.
- light.
- how volcaino irupts.
- posotions.
- I don't know.
- I don't know.
- no response.

Item #17 - Grade 3 - Females

- experiments.
- cutting frogs.
- about plants.
- electricity.
- same things that we were taught.
- things they normally teach in science.
- some interesting things.
- something that I can learn.
- no response.

Item #17 - Grade 8 - Males

What do you think should be taught in science classes?

- lab work.
- lab work.
- more lab work, dissections.
- science with more lab work.
- science, more lab work.
- sex ed., dissection, more lab work.
- lots of experiments.
- dissections, space, universe.
- chemistry.
- science, chemicals.
- human anatomy.
- space, animals, human body.
- about organisms and animals.
- living things.
- physics, biology.
- about the environment.
- the normal stuff.
- the usual.

Item #17 - Grade 8 - Females**What do you think should be taught in science classes?**

- Environment.
- Environment.
- Environmental subjects and the things around, on the trees and ponds like in nature.
- how to experiment things/Environment.
- biology, dissection.
- Distecting.
- Biology.
- Biology.
- Anatomy.
- More on animals.
- Sex ed.
- things that we will definitely need for the future.
- what they teach.
- whatever has to do with science.
- same topics.
- same topics.
- I really don't know.

Item #17 - Grade 11 - Biology - Males**What do you think should be taught in science classes?**

- information useful in daily life.
- practical information that can be useful to everyone.
- life and social sciences/human anatomy/same stuff.
- science.
- technology.
- science and technology.
- the curriculum is currently adequate.
- everything it teaches.
- what is being taught now.
- exactly what is being taught.
- I don't know.

Item #17 - Grade 11 - Physics - Males**What do you think should be taught in science classes?**

- science fundamentals. as well as how it relates to the world, to issues, and to the future.
- basic background to biology, chemistry and physics.
- science and how it effects the world.
- what is helpful to us in life.
- the world around us.
- more on the world around us.
- whatever there is to know.
- why things happen.
- new technology.
- what is being taught is fine. It should be taught faster.
- not sure.

Item #17 - Grade 11 - Science 24 - Males**What do you think should be taught in science classes?**

- do more experiments and labs.
- more hands on stuff such as dissecting.
- how things happen.
- how to have more fun scientifically.
- how things are made.
- carpentry.
- gas ratios to improve performance.
- science.
- everything we are doing now.

Item #17 - Grade 11 - Biology - Females**What do you think should be taught in science classes?**

- things that apply to everyday life, not just theory.
- how to apply the knowledge to everyday situations.
- the "whys" of things.
- human and animal behaviour / anatomy.
- everything we learn.
- everything we learn now.
- not sure.
- I don't know.

Item #17 - Grade 11 - Physics - Females**What do you think should be taught in science classes?**

- how science relates to everyday life.
- basic knowledge, things that we would use in everyday life.
- more things related to life.
- principles behind occurrences and functions.
- fundamental laws and hand on labs.
- science.
- more on creation as scientifically based instead of teaching kids that evolution is the fact based theory and creation is the story.
- what we learn now is good.
- not sure.

Item #17 - Grade 11 - Science 24 - Females**What do you think should be taught in science classes?**

- I think the issues that are in today's society.
- more about diseases and things tested on animals.
- how to operate machines, things to do with the environment.
- the environment.
- science

Item #19 - Grade 3 - Males

How can science teachers make the science classroom more interesting for science students?

- experaments.
- more exsparaments.
- by doing intresting sience icspeariments.
- more experements.
- have diffrent cemicals to ekperment with.
- biger lab.
- the lab.
- get blue, green, red and yellow posotions in the class.
- do something they like to do in scienc.
- try to get more people that know lots about science.
- show how.
- I don't know.

Item #19 - Grade 3 - Females

How can science teachers make the classroom more intresting for science students?

- do more actvatys.
- leming more aboit it.
- play science games.
- by being funny and doing fun stuff.
- put more fun into it.
- decrating it.

Item #19 - Grade 8 - Males

How can science teachers make the science classroom more interesting for science students?

- more labs.
- give more labs.
- give more labs.
- more labs.
- more lab work, more projects.
- more lab work.
- more experiments.
- more speriment.
- by adding more exparements.
- do lots of experiments.
- more experance.
- less writing, more labs.
- take them out to places and trips.
- by kidding around.
- take it like humorous.
- being creative.
- like it is.
- don't drag things on.
- I don't know.
- I don't know.

Item #19 - Grade 8 - Females**How can science teachers make the science classroom more interesting for science students?**

- hands on activities.
- hands on activities.
- hands on activities.
- more labs/less paperwork.
- by doing more experiments and labs.
- giving more labs and less lectures.
- more experiments.
- more labs.
- less talk and notes and more experiments.
- dead frogs we'll be able to dissect / more displays of scientific stuff.
- by bringing them on interesting field trips, and letting us dissect animals.
- play trivia games so it will be easier to remember things.
- play games so it will be easier to remember.
- be funny.
- be funny.
- discuss things but nothing really boring.
- let us do whatever we want.

Item #19 - grade 11 - Biology - Males**How can science teachers make the science classroom more interesting for science students?**

- more labs and experiments.
- provide experiments and hands on activities.
- more experiments and examples of the work.
- more labs that would amaze people.
- I don't know.
- Laser Disc material.
- field trips.
- films and experiments.
- have interesting experiments.
- more hand on work.
- use more technology.
- relate information to life experience.
- make it fun to be there and learn.

Item #19 - Grade 11 - Physics Males

How can science teachers make the science classroom more interesting for science students?

- more field trips and visual equipment.
- more labs, puzzles, videos. (things that challenge the thinking of the student.
- more experiments, hand on.
- more hands on activities.
- paint it one uniform colour.
- more hands on.
- more audio-visual such as Nova and National Geographic
- more fieldtrips
- greater speed through the fundamentals so that more interesting things can be done.
- more concentration on social issues.
- perhaps separate classes for those who are especially interested.
- have more hands on experiments.
- more visual components added to the course.
- more experiments.
- more demonstrations and less theory.

Item #19 - Grade 11 - Science 24 - Males

How can science teachers make the science classroom more interesting for science students?

- let students dissect human heart and other organisms.
- more experiments.
- give them lots of different labs.
- getting all students involved with experiments.
- more activities and demonstrations.
- do more demonstrations.
- more interesting field trips, visiting zoo, space centre.
- more movies.
- more movies.
- for the teachers not to come to class.

Item #19 - Grade 11 - Biology - Females

How can science teachers make the science classroom more interesting for science students?

- find different ways to distribute the knowledge besides lectures and notes.
- talk about how things relate to life.
- make us realize there is something in it for us. Explain how it affects us TODAY.
- I like it the way it is.
- more hands on stuff.
- more field trips, labs.
- have more interesting posters.
- with oomph, excitement. A little bit slower.

Item #19 - Grade 11 - Physics - Females

How can science teachers make the science classroom more interesting for science students?

- be an interesting teacher if they are not already.
- more hands on.
- relate it to life, things a practical person could use it for.
- relate it to everyday things so we will know how to use it when we get older.
- science experiments.
- more labs and audio-visual resources.
- more projects.
- more interaction between students and between students and teachers.

Item #19 - Grade 11 - Science 24 - Females

How can science teachers make the science classroom more interesting for science students?

- make the class more casual.
- make it more fun.
- by actual live diagrams, let the students have hands on experience with objects and let them discuss amongst themselves instead of having pages of notes that they will usually forget within hours of study.

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